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All Abstracts sorted by Program codes

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644	Accepted: Oral	WC.1
645	Accepted: Oral	WC.2

O01.1

Analysis of Storm Surge in Kobe, Japan caused by Typhoon Jebi, T1821, by using the in-situ observation data

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Abstract

Typhoon Jebi, T1821, hit Japan on 4 September, 2018, and a storm surge occurred in the harbor of Fukae Campus of Kobe University, Japan. The maximum tide level (TL) occurred between 14:16 and 14:18, and was estimated to be 305 cm by in-situ data such as traces of the surge, level gauge data and imaging data. The maximum deviation from the predicted TL was 254 cm. The main factor in the Jebi storm surge was the wind effect of the southerly wind on the inner part of Osaka Bay. The outside maximum water level in Fukae Harbor was 336 cm, and was 31 cm higher than the maximum TL. The flooding was produced not only by the overflow caused by the storm surge but also by waves overtopping. If the storm surge had occurred at the maximum TL of the year, flooding would have produced t by the overflow alone.

Keywords

Storm surge, Typhoon, Overflow, Waves over-topping

O01.2

Recent morphodynamics of the Northern Portuguese coast

Ana Bio[1], José Alberto Gonçalves[1,2], Isabel Iglesias[1], José Pinho[3], Luís Vieira[3], José Vieira[3], Gueorgui Smirnov[3], Luísa Bastos[1,2]

[1]CIIMAR, Portugal. [2]University of Porto, Portugal. [3]University of Minho, Portugal

Abstract

Coastal zones are highly dynamic land-ocean interfaces, vulnerable to anthropogenic impacts and natural hazards. The monitoring of coastal morphology and morphodynamics is important to understand their fundamental processes and assess erosion risks, particularly in a climate change scenario, where sea-level rise and intensification of extreme events are likely to increase coastal vulnerability.

In the present work, carried out in the scope of the MarRisk project (Interreg Spain-Portugal, 2017-2020), coastal morphodynamics in recent years was evaluated for stretches of the Northern-Portuguese Atlantic coast. Digital terrain (DTM) and surface models (DSM), derived from LiDAR and aerial photography data, respectively, collected in 2011, 2017 and 2018, were used to assess beach and dune morphodynamics, quantifying sediment budgets, changes in shoreline position and in beach and dune widths and volumes, as well as shoreface slopes. Results were analysed considering the types of beaches found in the region (sandy beaches, sandy beaches with rocky outcrops, pebble and rocky beaches) and the dominant wind and wave patterns.

Overall, the coastline was stable between 2011 and 2017, but retreated between 2017 and 2018. A significant increase in beach/dune volume was observed between 2011 and 2017, but partly attributable to differences in methodologies (i.e. LiDAR-derived DTM versus aerial-photography-derived DSM). The slight decrease observed between 2017 and 2018, was likely linked to seasonal effects. Beach dynamics differed per beach type, with highly dynamic sandy beaches, and less dynamic rocky and pebble beaches. Erosion/accretion patterns were also related to beach exposure, i.e. the direction of the coast line in relation to dominant wave and wind directions, and influenced by the presence of defence structures. Beach slope showed no clear effect on morphodynamics in our data. This work allowed identification of coastal sectors that respond differently to wind and wave regimes and assessment of their sensitivity and vulnerability.

Keywords

coastal vulnerability, coastal erosion, coastal risks, morphodynamics

O01.3

Seasonal variations in flocculation and erosion affecting the large-scale suspended sediment distribution in a tide-dominated estuary: the role of biotic effects

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Abstract

Estuaries often display seasonality in the estuarine-scale distribution of suspended particulate matter (SPM). Various factors determine this SPM distribution, including salinity intrusion, freshwater discharge, erodibility, and the capacity of cohesive SPM to flocculate and form larger flocs. The erosion and flocculation processes have been reported to be highly dependent on biotic agents excreted by bacteria and algae, such as sticky extracellular polymeric substances (EPS) and transparent exopolymer particles (TEP). Therefore, seasonality in these biotic effects may have a crucial imprint on seasonality in the estuarine SPM distribution.

Various authors studied the impact of abiotic factors, such as freshwater discharge, on the seasonal behavior of the large-scale SPM distribution, but the contribution of seasonality caused by biotic factors is mainly unexplored. In this presentation, we study the relative influence of biotic seasonality on estuarine-scale SPM distribution through erosion and flocculation. To this end, we apply a reverse engineering strategy and calibrate a coupled sediment transport-flocculation model to a unique, long-term turbidity (cf. SPM) data set observed in the Scheldt estuary. To validate our model results, we also compare the modeled floc sizes to in-situ observations, measured simultaneously with the turbidity profiles. Our calibration shows a limited biotic seasonality in flocculation (relative difference of ~10%), which falls within the uncertainty of the model and observations, and also shows that the erodibility of sediment does not need to be changed for different seasons. Observations of TEP, which are known to have a dominant impact on erosion and flocculation, strengthen our model results because these observations also lack a significant seasonal pattern. We conclude that the model captures both the observed seasonality in estuarine-scale SPM distribution and floc size. This seasonality is mainly driven by seasonality in turbulence and freshwater discharge and does not require seasonality in biotic processes that influence erosion and flocculation.

Keywords

sediment distribution, biotic seasonality, flocculation, erosion

O01.4

Creating estuarine habitat on formerly embanked land using controlled reduced tidal exchange

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Abstract

When considering marsh restoration on embanked land, managed retreat is not always an option due to site characteristics or safety considerations. Several techniques exist to regulate tidal exchange between an estuary and an embanked site. This presentation will focus on a restoration project that combines safety and ecology on an embanked site with an elevation far below mean high water. Flood control was combined with Controlled Reduced Tidal exchange (CRT), a form of Regulated Tidal Exchange (RTE). CRT allows the implementation of a tidal regime with a reduced tidal amplitude, yet with the reproduction of a neat spring-neap tidal cycle and variations similar to the tides in the estuary, whereas most RTE's reduce the essential inundation gradient by minimising the springtide – neap tide differences.

The CRT Lippenbroek was created in 2006 in an embanked site (8 ha) and is intensively monitored ever since. Here we will present results on hydrology, water quality, geomorphology, invertebrates and vegetation. We show how the tide was adapted to the elevation of the CRT area and how it evolved over time. Mass balance measurements demonstrated the biogeochemical ecosystem services such as carbon burial, nutrient burial (N and P) and Si delivery. A creek pattern developed, and a differentiated sedimentation/erosion pattern was found, showing however some important differences compared to the reference sites. Based on these results we will conclude with some guidelines for creating new CRT areas and their adaptive management.

Keywords

regulated tidal exchange, restoration, estuary

O01.5

Beach nourishment impact on coastal zone sediments and morphological changes in protected areas, Southeastern Baltic Sea (Lithuania)

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[1]Vilnius University, Lithuania. [2]Nature Research Centre, Lithuania

Abstract

Lithuanian protected coastal areas are included in the list of the protected territories of the HELCOM, and some are a part of the European ecological network Natura 2000. Palanga - the biggest Lithuanian seaside resort, is located near the Natura 2000 area, including waterfowl wintering grounds of international importance and the most biologically valuable reefs. To preserve the sandy beaches of Palanga suffered after the storms of the XX-XXI centuries, from 1993 to 2012, five beach nourishment projects were carried out by adding more than 600 thousand cubic meters of sand.

This study evaluates the impact of beach nourishment on the Palanga coast. It determines the effects on protected areas based on geochemical and lithological data of coastal sediments and morphometric changes from 1993 to 2018. The results showed that the fine-grained beaches became coarser, beach elevated and caused sand to move to the dune ridge and the nearshore. After the beach nourishment, the concentration of heavy minerals increased, the colour of the beach and the geochemistry changed, i. e. increased in Mo, Cu, Pb, Co, Fe, Th, P, Mg. Since the longitudinal currents face north near the Lithuania coast, significant changes in the beach sediments' analysed parameters have been identified in the north from the nourishment site. To date, little attention has been paid in Lithuania to assess beach nourishment projects' impact on natural habitats in protected areas. The research results showed that beach nourishment projects cause significant changes in geochemistry and lithology of the sediments of beach and surrounding areas and coast morphometric parameters. Although beach nourishment is considered one of the least harmful coastal protection measures and provides long-term recreational needs for humans, it might also have a detrimental effect on the seabed and coastal habitats in protected areas.

Keywords

beach nourishment, geochemistry, habitats, protected areas

O01.6

Water tables and drainage characteristics of intertidal sediments: lessons for spill response and remediation

David Little

Independent consultant, UK

Abstract

A survey of 12 shores in the UK and Ireland with different sediment types and tidal ranges highlighted variations of intertidal drainage. Periods of low water on spring and neap tides were selected at opposite ends of the hydrological year. Using surveying, piezometers, tensiometers, and sediment grain size analyses, 346 water table 'cases' were analysed by correlation and multiple regression. Proximity to the sea and vertical movements of the tide generate intertidal water table fluctuations. Drainage generally improves up-shore. Elevation on the shore and site specific sediment grain size parameters (mean, standard deviation, skewness) are important variables in water table behaviour, influencing the drainage and imbibition curves in the surface sediments. These curves tend to be ebb-asymmetrical in fine-grained, low-permeability sediments and more symmetrical in coarser sediments. The main factor affecting contrast between spring and neap tides is the volume of water entering the upper beachface during high water spring tides, leading to relatively slow ebb tide drainage. Topography of the shores modifies the general trend of seaward-decreasing amplitude of water table fluctuations. The multiple regression models then predicted drainage parameters elsewhere, including shorelines affected by large oil spills with extended oil residence times. Relatively well-drained upper shore muds are more prone to oil penetration than predicted by Environmental Sensitivity Indices (e.g. biogenic macropores in Saudi Arabia saltmarsh and mudflats after 1991 Gulf War oil spills; tropical mudflats and mangrove communities in Bodo creek, Rivers State, Nigeria after the 2008 Shell pipeline spills and subsequent oil theft followed by ongoing illegal refining). Relict gravel berms and armoured beach faces are not fully in equilibrium with present wave climate and sea level, and may be intercalated by fine-grained laminations and underlying peat layers that trap oil in low permeability layers (e.g. Prince William Sound, USA after the 1989 'Exxon Valdez' spill).

Keywords

Environmental Sensitivity Index, Oil residence time, Multiple regression, Seasonal or tidal factors

O02.1

Adsorption behavior of ^{210}Pb, ^{207}Bi and ^{210}Po onto marine particles and its influence in tracing marine process

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Abstract

The progeny of radon-222 (^{222}Rn), lead-210 (^{210}Pb), polonium-210 (^{210}Po) and bismuth-210 (^{210}Bi), serve as one of important tools in the study of marine particle dynamics. In this study, we investigated the partitioning of ^{210}Pb, ^{210}Po and ^{210}Bi (^{207}Bi) between seawater and solids under different values of pH and salinity. The K_d values of ^{210}Pb and ^{207}Bi for MnO_2 varied widely between the synthetic and natural minerals, and thus the suitability of using synthetic material for their partitioning studies in marine system needs to be re-assessed. The K_d values of ^{210}Pb in clay minerals were found to be in the order: smectite > illite > kaolinite. These radionuclides were more soluble when pH was ≤ 5, but show more particle-reactive nature for pH of 6 to 8. In the Southern Yellow Sea, the higher K_d values of ^{210}Po relative to ^{210}Pb generally increased with POC/TSM. The negative correlation between $^{210}Po/^{210}Pb$ activity ratios and primary productivities implies that marine biological processes may enhance the disequilibrium between ^{210}Po and ^{210}Pb. Diatom blooms would have enhanced the removal of ^{234}Th compared to ^{210}Po but would not change the scavenging of ^{210}Po, resulting in a higher POC flux estimated by ^{234}Th than ^{210}Po. The fractionation between ^{210}Po and ^{210}Pb ($F_{Po/Pb}$) varied with salinity for different mineral components while the $F_{Bi/Pb}$ was less affected by mineral components, salinity and pH. The in-situ experimental results showed that the $F_{Bi/Pb}$ increased with increase of Chl-a concentration and the occurrence of blooms could enhance the affinity of Bi compared to Pb. Considering the much shorter half-life of ^{210}Bi (5.0 d) and the K_d values established in this study, we propose that $^{210}Bi/^{210}Pb$ activity ratio could potentially be used to estimate the particle export from phytoplankton bloom on time scale much shorter than ^{234}Th or ^{210}Po.

Keywords

Seawater, 210Pb-210Bi-210Po, partitioning, mineral particles

O02.2

Social-environmental analysis of water quality in a populous urban estuary, case study of Tamsui River estuary

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Abstract

Estuary is a habitat that can provide unique ecosystem services to benefit mankind and maintain marine ecosystem health. However, the coastal environment including estuary and the ecosystem services they provided are facing fast degradation due to the increasing pressures and changes in the near future. Estuaries are highly dynamic, unique, and diverse ecosystems. It has been regarded as naturally stressed areas that are caused by the great variability of the physico-chemical characteristics in the water column. In addition, they are exposed to high degrees of anthropogenic influence, especially in a populous urban estuary. The high population density, the increasing anthropogenic pressures and ongoing environmental alteration, such as climate change and sea-level rise, which synergized the problems. Social-environmental analysis integrates not only scientific information but also social activities therefore provide a comprehensive knowledge for multi-parties jointing decision-making process in reaching successful sustainable management. In recent decades, Asia has been experiencing rapid urbanization, industrialization, and economic growth. Taiwan had been experienced the early economic growth in Asia and was one of the four Asian dragons, which underwent rapid industrialization and maintained exceptionally high growth rates between the early 1960s and 1990s. However, like many other countries, the environment has been sacrificed for economy growth. In 1990s, the pollution was getting serious and water quality of the rivers and estuaries went bad. In order to improve the water quality, several measures have been implemented. Notably, Taiwan is an island so its estuary systems are only governed in sole regime, which makes Taiwan one if not only ideal place to study. In this study, the historical data and information are employed in the social-environmental frameworks, driver-pressure-state-impact-response (DPSIR) framework and the systems approach framework (SAF), to analyze the water quality in the most populous urban estuary, Tamsui River estuary, in Taiwan.

Keywords

Social-environmental framework, DPSIR, systems approach framework, Tamsui River estuary

O02.3

Yangtze Estuarine Delta at transition?

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Abstract

The Yangtze Estuarine Delta (YED) has a long history of river and coastal flood protection with its fast progradation over more than two thousand years. The provision of sea level rise during the twenty-first century in combination with sediment compaction from the rapid urban expansion, the huge sediment trapping in tens of thousands reservoirs upstream and land reclamation in the estuary has updated the push for sustainable solutions to climate adaptation. Here we present the analysis results of historical and our measured data sets of surface water level, bathymetry, bed sediment and morphology from the upper YED to the lower YED. We find that in the past two decades, 75% of the channel with the submerged delta experienced severe erosion. Moreover, since 2013, in the estuarine turbidity maximum (ETM), subaqueous dunes have appeared along the channels and strong local scour have occurred around the basement of Sheshan Island and eastern head of the north jetty of Deep Waterway. Furthermore, tidal limit migrated quickly upstream ca. 220 km back to Jiujiang, where it was located in the Jin Dynasty over 2 ka years ago. We suspect that the YED is in a transit state from a fast progradation to a destruction phase since 2013, which is attributed to the intensive anthropogenic geomorphology changes during the last 50 years. It will be amplified by the SLR from climate warming, which also causes a severe flooding problem in the YED.

Keywords

Yangtze Estuarine Delta, subaqueous dune, engineering impact, sea level rise

O02.4

Long-term changes in phytoplankton communities in China's YangtzeEstuary driven by altered riverine fluxes and rising seasurface temperature

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Abstract

Phytoplankton communities have been changed recently in the giant and dynamical China's Yangtze Estuary primarily due to intensifying human activities and climate warming. A large amount of riverine material fluxes into the estuary has been significantly altered in their balances, leading to a change of phytoplankton from siliceous to non-siliceous-dominated communities. We established inter-linkages of changing phytoplankton communities to various controlling factors and revealed that this bio-transformation occurred around 2000. Before it, there were fewer dominant diatom taxa, but since then more have emerged as the variation, along with many dinoflagellates driven by the altered riverine N:P:Si delivered to the estuary, averagely from 75:1:946 (1960s–1970s) to 86:1:272 (1980s–1990s) and to 102:1:75 (2000s–2010s). Excessive nitrogen and lowering DSi has exerted the key environmental stress on such a bio-transformation. *Skeletonema* spp. the most popular in diatoms has lost its dominance by ca 50% since the early 2000s. We further convinced the long-increasing DIN (presently, 150 μmol L^{-1}, maxi., ca 3.5 folds more than that of 1960s–1980s) to meet the long-decreasing DSi (ca 60% off since 1960s) at 110 μmol L^{-1}, around 2004 (Redfield ratio balance 1:1) as a hreshold. Then, this balance has broken, serving as an engine for driving the bio-transformation. Phytoplankton development didn't fully follow the Redfield ratio, especially during the algal blooming season, as revealed by the scattered istribution of dinoflagelate:diatom vs. DIN:DSi when DIN:DSi >1. This implies a much more eutrophic setting attributable to over-loaded nitrogen concentration in the Yangtze Estuary. Besides, the lowering sediment flux in the estuary (lowest after 2003 when the Three Gorges Dam closed) and the rising SST in recent decades has enhanced the biotransformation. Consequently, the estuarine water tends to be more acidic, manifested by continuously lowering pH and DO in the study area.

Keywords

Riverine material fluxes, Nutrients balance, Bio-transformation, Eco-regime shift

O02.5

Ecological degradation of the Yangtze and Nile delta-estuaries in response to dam construction with special reference to monsoonal and arid climate settings

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Abstract

This study reviews the monsoonal Yangtze and the arid Nile deltas to understand the process-response between river-basin modifications and delta-estuary ecological degradation under contrasting hydroclimate dynamics. Analysis shows that the Yangtze River has had a long-term stepwise reduction in sediment and silicate fluxes to estuary due to dam construction since the 1960s, especially the Three Gorges-Dam (TGD) closed in 2003. By contrast, the Nile had a drastic reduction of sediment, freshwater and silicate fluxes after the closure of Aswan High Dam (AHD) , 1964. Seasonal rainfall in the mid-lower Yangtze basin (below TGD) complements riverine materials to its estuary, but little is available to the Nile coast below HAD in the hyper-arid climate setting. Nitrogen (N) and phosphate (P) fluxes in both basins have increased because of overuse of N- and P-fertilizer, land-use change, urbanization and industrialization. Nutrient ratios (N:P:Si) in both delta-estuaries have been greatly altered, in the context of the optimum of Redfield ratio (N:P:Si = 16:1:16). This has led to ecological regime shift evidenced by a long-term change in phytoplankton communities in the Yangtze estuary, where silicious algae tended to lose dominance since the end of 1990s, when more toxic dinoflagellates began to emerge. In the Nile estuary, such regime shift is indicated by the post-dam dramatic reduction in zooplankton standing crop and fish landings until the early 2000s when biological recovering due to anthropogenic sources. Although the Yangtze has had higher human impacts than the Nile, N concentrations in the Nile estuarine waters have surpassed the Yangtze. However, eutrophication in the Yangtze is much more intensive than the Nile, leading to the likelihood of more acidic water. The comparative insights of this study should be incorporated into future integrated coastal management of these two important systems.

Keywords

altered nutrient ratio, riverine flux, bio-transformation, post-dam consequences

O02.6

Morphodynamic evolution of the longitudinal profile in the Yangtze River Estuary in response to natural and anthropogenic interferences

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Abstract

The evolution of the longitudinal riverbed profiles is a critical feature of morphological adjustments in fluvial systems and might have important effects on channel stability, navigation, and floods control. For getting a better understanding about channel adjustment processes of this large deltaic channel, this study assessed three decades of morphological changes of 35-km long channel thalweg and longitudinal riverbed profiles in South Channel (SC) in the Yangtze Estuary. Sediment sampling and longitudinal river-bottom surveys were conducted by the instrument assembly system including the Seabat 7125 multibeam echo sounder (MBES), a dual frequency acoustic doppler current profiler (ADCP), and an EdgeTech along the thalweg on the SC. Results showed that the average elevation of the thalweg in the SC exhibited a nonlinear growth trend, with the average elevation increasing by 1.4m. Natural factor and human intervention play an essential role in the changes of thalweg. An antislope channel with about 20-kilometers length in the SC was developed and the longitudinal profiles of the antislope channel changed from concave to convex significantly. In a whole, the morphology of the SC are still in the adjustment to the reduction of riverine sediment supply. Dunes with small superimposed dunes were developed well along the channel thalweg in the SC and the antislope reach were normally covered by dunes on the entire bed. In general, dune wavelength increased with increasing water depth along the thalweg in the antislope channel and dune wavelengths ranged from 4.25 to 21.86m. This work provides new insights into the long-term morphological adjustment of longitudinal riverbed profile of estuarine channel to natural and artificial forcing and their implications for deltaic channel exploitation.

Keywords

Channel thalweg, Longitudinal profile, Morphological adjustment, Yangtze River

O03.1

Does hierarchical marine spatial plan help to coordinate transboundary issues in coastal bays of China?

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Abstract

Marine spatial planning (MSP) has been popular to address the conflicts between the coastal zone development and the marine environmental protection. However, this issue becomes more serious when it is combined with the transboundary issue. In the Fujian Province of China, the coastal bays are usually shared by two or more coastal cities, which makes the transboundary coordination a challenge. There is increasing discussion on this cross-border issue in MSP, however, few studies have been reported on either the approach or its effectiveness to address transboundary issue in MSP. This study aims to develop a method to quantitatively understand the difference of coordination effectiveness between a municipal level MSP and the provincial level MSP. First, the intensity of each sea use was scored from 1 to 10 based on its demands on marine resources and impacts on marine environment. Then, the development intensity of each bay was calculated based on the spatial distribution of the sea uses with Geographic Information System (GIS) tools. And the conflict intensity value was calculated through buffering tools in GIS. Through comparative analysis, the results show that the conflict intensity value and coordination value changes from the provincial level MSP to the municipal level. And for the same level MSP, its conflict intensity value is affected by its development intensity. The results will help to improve the coordination between provincial and municipal level MSP, and also inform potential future revisions of the coastal zone utilization.

Keywords

Marine Spatial Planning, coastal bay, development intensity, conflict intensity

O03.2

Dredging and disposal in UK estuaries and coastal seas: a review to date and a look to the future.

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Abstract

The UK, as a maritime state, historically and now, places a large reliance on the use of our seas. As a power house of British trade, the UK maritime and marine sectors support over 500,000 jobs and contributes £22.2bn to UK GDP. To enable the UK Economy to continue to thrive, especially following the COVID pandemic, dredging of the seabed is vital to support these maritime uses. Here we look at the history of dredging and disposal operations trends and changes currently influencing how these operations are evolving, like applying more formal transparent and robust risk based assessments. We review the requirements for new technologies and the impacts of other sectors like offshore renewable energy, on dredge material management including contaminant action levels, considering alternatives to sea disposal and more beneficial uses. We look at the challenges around these evolving aspects and recommendations to facing these. Finally, we look at the future of dredging and disposal: are these expected to increase? How may climate change or new technologies, like those introduced recently to reduce greenhouse gas emissions from vessels, impact industry? We consider all of these in line with our national and international obligations and processes to determine as scientists, industry and policymakers what we need to be aware of to ensure the ongoing strength of our maritime economy.

Keywords

Dredge, Disposal at sea

O03.3

Making coastal research useful: how to improve links between science, policy and practice in coastal management

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Abstract

Coastal research has generated extensive scientific knowledge about the sensitivity of coastal processes to natural and human influences and about possible pathways of future developments. However, integrating this knowledge into decision-making still remains challenging. Failing to incorporate scientific evidence into policy and practice could potentially lead to less effective or detrimental management actions.

Using a study from a long term Sino-German collaboration project, we explore how to bridge the gaps between science-policy-practice and how to connect them, and we discuss potential enablers to improve research uses for sustainable management of coastal resources. In doing so, we hope it can provide empirically-derived experience to help guide future research/implementation projects in this field and improve the sustainable management of coastal resources.

We identified that important issues are (i) to rethink scientific reward systems by recognizing stakeholder engagement activities, (ii) to use of knowledge brokering (knowledge broker or boundary organization) to support and facilitate the active and real-time exchange of knowledge between scientists and stakeholders, and (iii) to provide a more flexible funding. Modesty, self-reflexivity and skepticism are also needed on the side of science, as well as recognizing the importance of non-scientific knowledge in contributing to sustainable coastal development.

Keywords

science-policy-practice connection, stakeholder engagement, sustainable coastal development, knowledge exchange

O03.4

Decision support tools – performance and end-user needs for supporting coastal and marine policy implementation

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Abstract

Coasts and seas are under intensive human use and subject to degradation and spatial conflicts. To address these pressures, the European Union (EU) has adopted a wide spectrum of coastal and marine policies. Yet, their practical implementation is often challenging, causing delays and leaving policy objectives unmet. Decision support tools (DSTs), like models, GIS-based planning tools and assessment tools, play an important role in incorporating scientific information into decision-making and facilitating policy implementation. Yet, their use for supporting policy implementation is limited.

In an interdisciplinary Baltic research group, we compiled 43 DSTs developed to support ecosystem-based management of the Baltic Sea and conducted a thorough review. Analyzed DSTs cover a wide variety of policy issues (e.g., eutrophication, biodiversity, human uses) and address environmental as well as socio-economic aspects. Based on a set of performance criteria we analysed the current performance of DSTs available in the Baltic Sea Region. In addition, we conducted two surveys, in which we assessed awareness and use of DSTs in general, as well as policy implementation challenges and DST needs of representatives of public authorities, in particular. Furthermore, we conducted a policy review to identify major policy issues, policies, and general implementation steps and requirements and develop a synthesis-matrix, which was used to compare DST demand and supply to identify gaps, and to provide recommendations for future DST development.

The Baltic Sea Region serves as a best practice case for studying DSTs and their practical use, as it is intensively studied and regional management has been ongoing for decades. Hence, our results can provide insights for DST development in other marine regions. Furthermore, our methodological approach is transferable to other areas.

Keywords

science-policy interface, tools and approaches, end-user needs, decision support

O03.5

Collaborative process for the reduction of marine litter – RIVERSEA Project

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Abstract

The prevention and reduction of marine litter has a key role in the quality of fishing resources, due to its negative impact in marine biodiversity and in the fish diet, impacting human.

The RIVERSEA Project focus in the terrestrial sources of marine litter and microplastics promoting the implementation of strategies at the hydrographic basin level that will contribute to the prevention and reduction of the amounts of waste of terrestrial origin – today accounting for 80% of the marine litter – from reaching the sea. To achieve this a search for joint solutions engaging and mobilizing multi-stakeholders aiming the prevention and the reduction in the source is attempted. The project integrates the collection and characterization of samples and the evaluation of inputs to the Ocean, simultaneously promoting the literacy about the liberation of microplastics through a collaborative process of involvement and capacitation of stakeholders. This type of process has the capacity to reduce possible conflicts and to allow the identification of joint or individual solutions for the implementation of strategies for the reduction of marine litter.

Due to the pandemic COVID – 19 situation, this collaborative process expected to be conducted face to face, had to be reformulated to online sessions. In this paper the implemented process is described calling attention to the role played by the FMEA – Failure Mode and Effects Analysis - methodology in the engagement and mobilization of the stakeholders. This methodology aims to support the industries and their activities in minimizing the liberation of microplastics to the environment.

In this paper a reflection is done how this central element played a key role with added importance for the involvement of the stakeholders, having the project team worked as a facilitator element towards science communication.

Keywords

collaborative processes, marine litter, FMEA, multistakeholders

O03.6

Natural hazard versus *natural disaster* designation in the United States: how small differences in terminology can lead to large differences in coastal management policy.

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Abstract

The United States has a long history of providing financial assistance to those it deems have suffered through no fault of their own. In the parlance of federal disaster assistance, this has generally meant the harm is caused by "natural" phenomenon outside human agency. When the harm is seen as "human-caused," for example economic recessions, there has been a consistent reluctance to provide financial relief to those impacted. This presentation looks at this dynamic through the lens of coastal climate change adaptation. Questions posed include the following. Should the impacts of climate change (e.g., increased storm frequency and intensity) be seen as entirely "natural" from a disaster relief perspective? And if so, what impact does this have on a sense of individual and group responsibility towards climate change? Alternatively, if seen as "human-caused," does that increase individual responsibility for the impacts (e.g., home damage due to coastal storm surge) and thus preclude taxpayer subsidized relief to those impacted?

Keywords

coastal adaptation, natural disaster, natural hazard, policy outcomes

O04.1

Successful integration - Introduced alien species may have native friends in the Wadden Sea ecosystem

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Abstract

The introduction of non-indigenous species may cause strong effects on biodiversity, species interactions and functioning of native coastal ecosystems. Especially introduced bioengineering organisms may fundamentally change native soft-bottom ecosystems by modifying existing benthic habitat structures and thereby habitat-specific species interactions.

The introduction of Pacific oysters *Crassostrea gigas* into the sedimentary coastal area of the south-eastern North Sea and its preferred settlement on native blue mussel shells caused a large-scale shift from pure epibenthic *Mytilus edulis* beds to current mixed reefs of mussels and oysters.

To investigate whether the newly developed biotic habitat affects the occurrence of associated key organisms and their ecological functions, we studied the long-term occurrence of periwinkles *Littorina littorea* and their grazing activity on barnacles attached to Pacific oyster shells in the northern Wadden Sea.

We found no negative effects of oyster density increase on periwinkle population dynamics in the last two decades, which spans a time-period from the beginning of Pacific oyster establishment on mussel beds to oyster dominance today.

A manipulative field experiment revealed that density of *L. littorea* significantly affects the recruitment success of barnacles *Semibalanus balanoides* on oyster shells. The highest number of barnacle recruited at periwinkle exclusion. Thus, snail density and resulting grazing activity may control barnacle overgrowth on oyster shells, which is known to cause detrimental effects on overgrown bivalves. The company of introduced oysters and native periwinkles in the Wadden Sea shows that alien species may find native friends in newly conquered ecosystems with mutual benefits.

Keywords

non-native species, Pacific oyster Crassostrea gigas, Blue mussel Mytilus edulis, epibiosis

O04.2

Effects of seagrass recovery on the food web of the northern Wadden Sea

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Abstract

In contrast to global trend, seagrass beds recovered in extension and density in the northern part of the European Wadden Sea, but ecosystem effects of seagrass recovery are largely unknown. We used temporal-dynamic food web modeling Ecopath with Ecosim to assess potential ecosystem effects of seagrass recovery in the semi-enclosed Sylt-Rømø Bight at the German-Danish border. In addition to changes in the system's structure and functioning over time, the model predicted changes in biomass of seagrass associated species. Seagrass consumers increased due to an increased food supply. Likewise, the majority of seagrass meadow inhabitants increased in biomass due decreased predation pressure. In accordance to this, predators of the inhabitants decreased in biomass. With increasing seagrass meadows, the model predicted an increase of ecosystem services such as carbon sequestration and touristic attractiveness of the study site. Indirect mediation effects of seagrass severely influenced the model output and are thus crucial to forecast potential effects of the recovery of habitat-forming species. Holistic approaches such as food web models could provide a suitable basis in predicting ecosystem effects of changes in the biomass of habitat-forming species such as seagrasses.

Keywords

Ecosystem effects, Ecosystem services, Recovery effects, food web modelling

O04.3

Wadden Mosaic: Understanding the ecological functioning of the subtidal Wadden Sea

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Abstract

The Wadden Sea is of great ecological importance and supports many species of birds and fish. These species depend on a plethora of benthic invertebrate species living in the sediment. While the intertidal mudflats are relatively well studied, the biodiversity and food web structure of the subtidal Wadden Sea is relatively unknown. It is thought that the sea floor once consisted of a diverse mosaic of sand, silt, boulders, mussel beds, shells, seagrass beds, flat oysters and other structures, but there are indicators that this mosaic has become more homogeneous over time. Over the course of the next four years, the Wadden Mosaic project aims to shed light on this hidden part of the Wadden Sea. We will map biodiversity and link the benthic communities to habitat characteristics. In addition, we will test the feasibility and effects of possible management actions by: i) applying hard substrates, ii) (re-)introducing epibenthic shellfish beds, iii) testing restoration possibilities of subtidal seagrass meadows and iv) testing the effectiveness of excluding bottom trawling fisheries from marine protected areas. Here, we will present the first results from a large sampling campaign of 1394 boxcore samples, which were taken in a sampling grid throughout the whole subtidal Dutch Wadden Sea. Overall, the results from the project will improve our understanding of the ecological functioning of the subtidal Wadden Sea, and predict the effectiveness of management practices aimed at sustaining or increasing biodiversity.

Figure 1. Boxcore samples are used to investigate the sediment and community composition of the subtidal Wadden Sea. In this case an epibenthic shellfish bed was sampled.

Figure 2. Visualization of all 1394 subtidal locations (circles) where boxcore samples were taken.

Keywords

Subtidal Wadden Sea, Boxcore, Biodiversity, Food web structure

O04.4

Worms unlimited: high benthos density relaxes diet competition between fish in intertidal salt-marsh creeks

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Abstract

The submerged vegetation of salt marshes is worldwide valued as feeding habitat for fish. In Wadden Sea salt marshes, however, only the creeks are regularly flooded and in the past these were optimized for dyke drainage – not for fish. Knowledge of the habitat-species relationship is essential for an effective conservation of species. We present the first evaluation of the feeding habitat quality of German salt-marsh creeks for four characteristic species: three-spined stickleback, common goby, sand goby, and herring. Habitat-specific dietary condition, stomach contents and potential food competition – based on diet overlap and predator and prey abundances – were compared in four intertidal salt-marsh creeks and in the adjacent subtidal. Long-term body condition was similar between the two habitats, while instantaneous feeding rates tended to be higher in the marsh creeks for herring, stickleback and common goby. The diets of sticklebacks and gobies were dominated by polychaetes in the marsh creeks and by zooplankton and various crustaceans in the subtidal. Herring consumed mainly copepods in both habitats. Endobenthic prey was significantly more abundant in the muddy marsh creeks, whereas the zooplankton abundance did not differ between the habitats. Despite a higher diet overlap, low predator and high prey abundances relaxed the competition for endobenthic prey in the marsh creeks. We conclude that habitats characterized by low flow velocities and, thus, muddy sediments, such as marsh creeks, provide small fish with favourable foraging conditions through high density of endobenthic prey. The extent and availability of profitable feeding habitats is a powerful driver of fish population dynamics. Historically, coastal protection resulted in an extensive loss of marsh areas and, with it, feeding habitat for fish. Today, it may be worthwhile for the conservation of fish in the Wadden Sea to protect and promote the development of large, long, deep and easily accessible salt-marsh creeks.

Keywords

salt-marsh creeks, fish habitat value, diet competition, body condition

O04.5

Lost in translation – just another plan for the Wadden Sea World Heritage?

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Abstract

The Wadden Sea was inscribed on UNESCO's World Heritage List in 2009 and extended in 2014 in recognition of its Outstanding Universal Value (OUV) which recognises geological, ecological and biodiversity values of global quality. To ensure the protection of this unique ecosystem for the benefit of present and future generations of humankind, Denmark, Germany and the Netherlands established a Trilateral Wadden Sea Cooperation (TWSC) as a tool for cooperation and coordination. In over 40 years, the three countries have built independently and in trilateral collaboration, a comprehensive management system. Various trilateral nature conservation and management instruments have been developed in the last decades at the local, national, but also at EU level. In view of the multitude of plans, strategies and other management instruments, a single integrated management plan (SIMP) was requested by the World Heritage Committee in 2014 i. a. to provide a clear overview on how the three countries work together and leverage the existing regional and local strategies, management plans, plans of actions and networks. The SIMP development is coordinated by the Common Wadden Sea Secretariat, as the coordinating body of the TWSC and the relevant trilateral groups, the governance bodies and site managers of the property. Among the added values of this plan are the presentation of an updated overview of the existing national and regional governance for nature conservation management and an assessment of the direct association to the OUV. Trilateral, regional, and local strategies and plans are describing the joint work and conservation approach and relevant key aspects to further strengthen the cooperation. This knowledge made accessible seems to be among the important aspects for strategic planning and decision making with the objective of further improving feasible management measures.

O04.6

Restoration potential for subtidal shellfish populations in the Dutch Wadden Sea using hard substrates

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Abstract

Despite the official status as nature reserve, epibenthic shellfish populations have severely declined from the Wadden Sea over the last decades. The decline is thought to be caused by a combination of overharvesting, habitat destruction, heat waves, and diseases. Given the importance of epibenthic shellfish populations as ecosystem engineers, the loss of shellfish beds reduces habitat diversity and ecosystem services provided by these shellfish communities. In order to enhance the natural values and habitat diversity in the Wadden Sea, it is important to restore shellfish beds and their associated ecosystems. Previous research has identified some vital processes determining restoration success of intertidal oyster and mussel beds. Specifically, a lack of suitable attachment substrate and high predation pressure were shown to cause critical thresholds hampering natural re-establishment in intertidal shellfish beds. Providing complex structures that provide suitable surface for attachment while reducing predation pressure on shellfish may be a promising restoration approach. Although the ecosystems of the intertidal and subtidal Wadden Sea are tightly interconnected, not much is known about the critical factors for restoration of subtidal shellfish beds. This study therefore examines the potential of restoring shellfish beds in the subtidal Wadden Sea, with a focus on reef building oyster and mussel populations. In a first exploratory field experiment, six different types of natural or biodegradable settlement substrates for shellfish recruitment are tested and compared in both the Eastern and Western Wadden Sea. Additionally, the role of differences in substrate complexity in recruitment of shellfish is evaluated using 3D printed structures with varying standardised habitat complexity. Differences in settlement success between the types of substrates are evaluated, to decide which show the highest potential for scaling-up to larger scale restoration projects in order to contribute to science-based management decisions.

Keywords

Restoration, Shellfish, Wadden Sea, Settlement substrate

O05.1

Abundance and reproductive migration patterns of the alien species *Callinectes sapidus* in a protected area of the Spanish Mediterranean coast

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Abstract

The blue crab *Callinectes sapidus* has been distributed globally in the later years. On the Mediterranean coast of Spain it is present since 2012. In the Albufera of Valencia, a protected coastal lagoon communicated with the sea throughout three channels equipped with floodgates, *C. sapidus* has been abundant since 2016. The lagoon has an extension of 24 km^2 and salinity ranges from 0.6 in the inner part to 29.6 at the mouth of the channels. The main objectives were to estimate the abundance and to study the reproductive migratory patterns of *C. sapidus* in this area.

Carapace width, sex and maturity stage were recorded for all specimens caught using baited traps in 2017 and 2019 in different areas. In 2019, the sampling was focused in an area close to the main channel mouth of approximately 0.05 km^2 where specimens were tagged for capture-recapture data, using coded aluminum plates. A POPAN analysis was performed on capture-recapture data using the MARK software.

In 2019, 240 crabs were tagged and released. Of those, 34 tagged crabs were recaptured. POPAN analysis revealed an estimated abundance of 594 crabs/0.05 km^2. Females were more abundant close to the channel mouth during late July and August. Its presence also increased in October. Immature females were bigger in the lower salinity areas. Spatial segregation by sex was clear, males being more abundant in the lower salinity areas.

The estimated density was lower than the one determined in close estuarine environments. The floodgates might be playing an important role in this system by preventing strong spatial segregation by sex. They also create an abrupt change in the salinity that might be responsible for the differences in females' sexual maturity size. This implies that floodgates can be used as a population control tool, trapping ovigerous females inside the lagoon.

Keywords

Alien species, Density, Capture-recapture, Management

O05.2

Influence of natural and anthropogenic factors on larval fish assemblages in the Douro estuary (NW Portugal)

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Abstract

During the initial life stages, fish larvae are highly vulnerable to a suite of environmental factors that control larval survivorship and influence their distribution. The present work aimed to characterize spatio-temporal distribution patterns of the larval fish assemblage of an urban estuary and investigate the influence of environmental factors in their structure and composition. Monthly sampling surveys were conducted for two years, at nine stations distributed along the Douro estuary (NW Portugal). Sub-surface plankton tows were performed using a 500 µm mesh net. Physical-chemical water parameters were measured *in situ* and the contamination by microplastics was evaluated following Rodrigues et al. (2019). A total of 2 406 fish larvae belonging to 36 taxa were identified belonging to four functional guilds: estuarine species, marine migrants, marine stragglers and catadromous species. The Douro estuarine larval fish assemblage was highly dominated by few but abundant taxa as the resident *Pomatoschistus microps* and marine representatives of Clupeidae and Soleidae families. During the spring-summer period, abundance and diversity of the larval assemblage increased, associated with higher water temperature and decrease of river flow. According to CCA analysis, the Douro estuarine larval fish assemblages were mainly controlled by water parameters as salinity and hydrological features as river flow. Different types of microplastics were found, namely fibers and fragments, with a concerning mean abundance of 17 microplastics 100 m^{-3} surpassing the mean abundance of fish larvae (11 fish larvae 100 m^{-3}). Results reinforced that larval fish assemblages of the Douro estuary were highly vulnerable to environmental variations, which affected their distribution and diversity, and that anthropogenic pollution may pose additional pressures upon these sensitive life stages of fishes.

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Keywords

Early life stages of fishes, Temporal and spatial patterns, Environmental factors, Microplastics

O05.3

Larval fish dynamics in a coastal marine protected area (PNLN).

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Abstract

The Iberian Northwestern coast is an essential spawning and nursery area for several fish species, some with importance to European fisheries. This study investigated for the first time the dynamics and influence of environmental variables on larval fish assemblages in a small coastal marine protected area, Parque Natural Litoral Norte (PNLN), located off the NW Portuguese coast near important fisheries grounds and estuarine nursery areas. The temporal-spatial dynamics of the larval fish assemblages were investigated seasonally for 2 years, from autumn 2017 until summer 2019, at nine sampling stations equally distributed throughout the study area. In parallel, abiotic and biotic parameters were analyzed to identify the environmental drivers of PNLN larval fish assemblages. During the study 4170 fish larvae were collected, belonging to 39 different taxa. Twenty-three taxa were classified as marine stragglers including ten with commercial interest. Five taxa were classified as marine migrants all with commercial interest; and six as estuarine species, none with commercial interest. Overall, diversity was low and larval fish assemblages were dominated by three taxa responsible for 79.1% of the total larvae collected: two non-commercial species *Parablennius gattorugine* (54.6%) and *Ammodytes tobianus* (15.7%), and Clupeidae n.i. (8.8%) with commercial interest. Larval fish assemblages presented a strong seasonal pattern, associated with temporal variability of specific water parameters as temperature, pH, PO_4, chlorophyll *a*, TPM and river-flow, as identified by CCA analysis. Larval fish assemblages were mostly composed by reef-associated species and marine commercially exploited species that use estuaries as nurseries areas, indicating that PNLN is an important fish habitat for marine fish species. Moreover, almost half of the fish larvae (47%) were from species commercially exploited by fisheries, highlighting the importance of this small coastal MPA to help protect vulnerable early life stages of fishes and ultimately contribute for the preservation of fish stocks.

Keywords

Ichthyoplankton, MPAs, Environmental control, Seasonal dynamics

O05.4

Biological trait modality responses to different anthropogenic pressures in the Belgian Part of the North Sea

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Abstract

Knowledge of the functional diversity of a community is key to understand how the community responds to environmental and anthropogenic stressors. Indicators derived from biological traits could be more suitable to quantify the sensitivity of benthic communities and can be used to detect changes in ecosystem functioning within environmental impact assessments. The Belgian Part of The North Sea represents a highly dynamic area that is subject to a variety of human activities. Within this study, three different physical impacts - dredge disposal, sand extraction and offshore wind farms - were used to assess differences in functional diversity of macrobenthic communities between impact- and control areas.

A total of ten traits were selected, incorporating both response- and effect traits. Functional diversity was then quantified by calculating different indices: FRic, FDiv, FEve, FDis and RaoQ. Shifts in trait composition were determined by Fuzzy Correspondence analysis.

Under chronic disturbance such as high dumping or extraction, the functional diversity indices showed a clear response, especially in terms of functional richness. Within the offshore wind farms, these were less pronounced and also seemed to vary between the two wind farms, however clearly more species that had an attached lifestyle were observed. This is in contrast with the dredging sites, where a shift towards free-living species was observed, and at the extraction sites, which had a bigger proportion of species living at the surface level. A general trend is the shift towards a dominance of small-bodied, short-lived species without a larval stage.

The different types of impacts and levels of disturbance provided the ideal platform to assess the potential of biological trait-based indicators. While responses appear to be complex and case-dependent, results from this study show that the implementation of this type of analysis should be considered as a complementary tool in future environmental impact assessments.

Keywords

macrobenthos, dredging, sand extraction, offshore wind farms

O05.5

Primary production varying with water column depth and turbidity and chlorophyll a concentration, related to sediment resuspension, in a highly turbid estuary

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Abstract

The Guadalquivir estuary in the SW of Spain is a highly anthropogenically impacted estuary, with high nutrient inputs from waste water and agricultural run-off. Freshwater inflow is mainly controlled by a dam situated at 110 km from the estuary mouth and the estuary is partially canalized and largely isolated from the bordering tidal marshes and potential foodplains. As a result, the estuary is highly turbid and therefore considered net heterotrophic.

However, the estuary is vital for the recruitment of fisheries stocks in the Gulf of Cádiz (Atlantic), being the nursery area for important species like anchovy and sardine, which depend on primary productivity and secondary productivity of the lower levels of the food web in the estuary.

Microscopic observation and fatty acid analyses of suspended particulate matter in the estuary revealed a high diversity of phytoplankton, consisting of 50% diatoms along the whole salinity gradient, with increasing nutritional value towards the more saline zone.

As part of a long-term monitoring and ecological study, monthly measurements were performed at two sites in the Guadalquivir estuary. With a multiparametric sonde temperature, salinity, oxygen, turbidity and chl *a* were registered at 5-min intervals during 2 tidal cycles. Light penetration was evaluated by measurements with a quantum sensor and primary productivity was measured by O_2 bottle incubations.

We found that turbidity and chl a strongly and similarly fluctuated over the tidal cycle, indicating the resuspension of sediments and asociated chl *a*, consisting of phytoplankton and microphytobenthos, by tidal currents. We present results of depth- and time-integrated primary production (PPd) and show how this variation of turbidity (light penetration) and chl *a* influences calculated PPd for water columns of different depth. We suggest that the spatial heterogeneity of primary productivity and the resuspension of microphytobenthos explain the relatively high chl *a* concentrations observed.

Keywords

estuary, turbidity, phytoplankton, primary production

O05.6

Long-term monitoring of phytoplankton in a changing estuary

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Abstract

Since 1996, phytoplankton biomass and composition has been monitored in the Zeescheldt estuary (Belgium) using microscopy and HPLC pigment analysis.

Time series analysis of Chlorophyll-a revealed a decreasing trend in phytoplankton biomass from 2002 onwards. The peak Chl-a concentration in the brackish and freshwater zone had an annual decrease of 10 % and 2 %, respectively, and occurred on average 3 days earlier every year. Pigment analysis showed that diatoms and green algae are the major contributors to phytoplankton biomass and that their relative importance remained fairly constant throughout the entire period. However, significant changes in phytoplankton species composition occurred, corresponding to three main periods. The first period (2002) had high concentrations of ammonium, nitrite and nitrate and was dominated by chlorophytes (*Tetrastrum, Crucigenia* and *Scenedesmaceae)* and diatoms (*Aulacoseira)* in the brackish zone, and *Tetrastrum* and pennate diatoms in the freshwater zone. The second period (2003 – 2011) was characterized by a gradual decrease of N compounds, due to the progressive improvement of wastewater treatment, and an increase in temperature, particulate organic carbon, dissolved organic carbon and total phosphorous, linked to the increase of *Actinocyclus*, cryptomonads and rhodomonads. In the third period (2012-2018), Thalassiosirales and pennate diatoms increased in both zones, which appeared to be related to a decrease in discharge in the freshwater zone and increased salinity in the brackish zone. Cyanobacteria increased throughout the year in the freshwater zone, but only in winter in the brackish zone. In both zones, dissolved oxygen concentration was higher compared to the two previous periods, while turbidity (~ SPM) increased in the summer months and pH in the winter months.

Our results show that phytoplankton in the Scheldt estuary responded rapidly to the changes in nutrient inputs, and that changes in SPM levels, saltwater intrusion and discharge are important drivers of phytoplankton community assembly.

Keywords

Long-term, Phytoplankton, Scheldt estuary, Biodiversity

O05.7

Ocean colour as a valuable tool for assessing phytoplankton bloom phenology patterns in upwelling-influenced regions

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Abstract

Phytoplankton bloom phenology (i.e. the study of the annual timing and intensity of phytoplankton blooms) is key for the understanding of marine ecosystems. Changes in bloom timing and intensity can have harmful consequences for the pelagic ecosystem, such as mismatches between phytoplankton blooms and fish spawning, which may have severe impacts on pelagic fish communities and, consequently, on fisheries. Because of its role, its sensibility to exogenous forcing and specificity to different oceanographic regimes, phytoplankton phenology has been suggested a major indicator of changes in the pelagic ecosystem. This study aimed to assess phytoplankton bloom phenology in the Western Iberian Coast (WIC), a complex coastal region located in SW Europe, using a state-of-the-art long-term ocean colour dataset with daily resolution. Satellite-derived Chl *a* was used as a proxy of phytoplankton biomass. To account for the spatial heterogeneity of WIC, the region was partitioned into phenoregions (i.e. coherent regions according to selected phenology metrics). Random forest (RF) models (Breiman, 2001; Breiman and Cutler, 2004) were used to identify and evaluate the main drivers of each metric of bloom phenology. Bloom phenology off WIC was seen to be complex, matching its oceanography. Five phenoregions were identified, characterised and their drivers identified. Overall, oceanic phytoplankton communities were seen to form typically long, low-biomass spring blooms, mainly influenced by atmospheric phenomena and the conditions of the water column. Coastal phytoplankton, however, was characterised by short, high-biomass highly heterogeneous blooms, as nutrients, sea surface height, temperature and water flow had a major role in shaping phenology. Wind-driven upwelling and riverine input were seen to be major factors in influencing bloom phenology. This work is expected to contribute with relevant information for managing WIC and other upwelling regions, particularly under the current the threat of climate change.

Keywords

phytoplankton, bloom phenology, ocean colour remote sensing, Western Iberian Coast

O06.1

Water shortage and countermeasures of irrigation area surrounding poyang lake in dry season

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Abstract

In recent years, under the influence of a series of human activities represented by the Three Gorges Dam, Poyang Lake has the phenomenon of prolonged low water period. The shortage of water resources increases in the irrigation area around the lake, and there is an urgent need for solutions. Due to the close relationship between water intake of the irrigation area around the lake and lake level, this paper applies the P-III distribution to the water level of Xingzi Station from 1953 to 2018 to obtain mean annual water level and monthly mean water level in the dry season for 80th forecast percentile. Then, the hydrological year is selected according to the mean water level and the effective irrigation area for each year. The difference between water supply and demand of the irrigation area around the lake equals the amount of water shortage. Finally, according to the MK trend test results of runoff and the principle of water balance, we put forward the countermeasure that the existing projects can be used to adjust the flow of the Yangtze River to meet the water demand of the irrigation area around Poyang lake and make a quantitative analysis of its feasibility. The results show that the water shortage of irrigation area around Poyang Lake from September to February of the next year has reached 212 million m^3, 261 million m^3, 58 million m^3, 58 million m^3, 55 million m^3 and 26 million m^3 since the operation of the Three Gorges Dam in 2003. The water shortage in dry season can not be solved by regulating the runoff of the Yangtze River. Other more effective measures should be taken to improve the current situation, such as the construction of Poyang Lake Hydraulic Project.

Keywords

Poyang Lake, water shortage, dry season, Irrigation area

O06.2

Comprehensive evaluation and countermeasures for sustainable development of coastal zone in Shandong, China

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Abstract

The assessment of the coastal zone sustainable development is an important basis for the government to make policies and manage the coastal zone. In this study, from the dimension of resource, environmental, economic and social subsystems, 30 indicators were selected including per capita water resources, the proportion of environmental protection investment accounted for fiscal expenditure, per capita GDP, population density and so on. Accordingly, a system dynamics prediction model reflecting the dynamic changes between indicators was established, and ten scenarios combined by GDP growth rate and population growth rate were simulated and analyzed. Furthermore, three comprehensive indexes of development degree, coordination degree and sustainable development degree as well as the improved entropy method were used to calculate the sustainable development status of Shandong coastal zone from 2008 to 2017 and the next ten years. The results showed that the sustainable development capacity of Shandong coastal zone was at a medium level with an increasing trend, but this growth pattern would have potential ecological and environmental problems in the long run; The spatial distribution presented a pattern of high east and low west. The GDP growth rate has a greater impact on coastal zone sustainable development while the population growth rate has a smaller impact. According to the prediction results, proper suggestions are given to for Shandong coastal zone management.

Keywords

coastal zone, sustainable development, comprehensive assessment framework, system dynamics

O06.3

Changes of sediment dynamics within turbidity maximum zone in response to reclamations in the Yangtze (Changjiang) Estuary, China

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Abstract

Reclamation in estuaries can greatly change the channel geometry and hydrodynamic conditions and these changes may have significant impacts on spatial and temporal distribution of the turbidity maximum zone. This study focuses on effects of large area of reclamation built in 2007-2018 on the behavior of the turbidity maximum zone along the North Channel of the Yangtze Estuary. Data were collected of bathymetry in the North Channel, tidal elevations at Sheshan Station, river discharge at Datong Station and turbidity data were retrieved from six Landsat remote sensing images in the dry season from 2006 to 2019. In-situ measured data of flow velocity and suspended sediment concentration were obtained in dry season of 2003, 2012 and 2018. Analysis of the data revealed that reclamations, which led to narrowing (0.86 - 2.74 km) and fixing of the channel, caused erosion of 0.19-3.72 m in the deep channel and deposition on the tidal flats. The width of the turbidity maximum zone decreased: during spring/neap tide in the dry season, its landward boundary shifted 5-6 km seaward.

Keywords

Suspended sediment, Estuarine engineering, Turbidity maximum zone

O06.4

Variations of tidal dynamics in the last 50 years in the Huangpu river of Shanghai, China

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Abstract

The Huangpu river is a tributary of the Yangtze River, flowing into the Yangtze Estuary through Shanghai Municipality. It is important for Shanghai's development. The water dynamics of Huangpu river are affected by not only waters from upper Taihu basin but also tidal dynamics of the Yangtze Estuary. The low water levels in dry season and high water levels in flood season are related to shipping and safe of the Shanghai city respectively. In the last decades, many water conservancy projects were constructed in the upper Taihu basin and Yangtze Estuary. These projects and climate change could induce large variations of water dynamics. In this research, we investigate the trend of tidal levels, tidal ranges, and durations of flood and ebb tides, change of frequencies of the highest and lowest tidal levels, and driving factors for variations in the last 50 years.

O06.5

Characteristics and driving mechanisms of mixing and stratification in the North Passage of the Changjiang Estuary, China

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Abstract

After the implementation of large-scale deep-water channel regulation project in the North Passage of the Changjiang Estuary, the channel has been faced with the problem of large amount of siltation, at the same time, the mixing and stratification process of water column has an important impact on sediment transport. Based on the measured hydrological and sediment data of spring and neap tides in dry and flood seasons of 2016 in the North Passage of the Changjiang Estuary, the gradient Richardson number, Simpson number and potential energy anomaly were calculated to analyze the tidal cycle, spring-neap variation and seasonal variation of mixing and stratification. Taking into account the vertical difference of horizontal density gradient, the contribution terms of time derivative of potential energy anomaly was derived, including depth-mean straining, advection, non-mean straining and tidal stirring. The driving mechanisms of mixing and stratification was investigated by calculating and comparing these four contribution terms. The results show that the seasonal variation of freshwater discharge mainly affected the distance of saltwater intrusion, the saline wedge moved upstream in dry season, while the tidal dynamics had significant impacts on mixing and stratification. In the reaches with saline wedge tip migration, the water column was periodically stratified, and the process was dominated by advection term. In the main reaches of saltwater intrusion, during spring tide, the water column was periodically stratified, which was stratified during flood tidal current, and well mixed during ebb tidal current, and the stratification during flood tidal current was promoted by advection and depth-mean straining, and the mixing during ebb tidal current was promoted by tidal stirring and advection; during neap tide, the water column was permanently stratified, the stratification was enhanced during flood tidal current and weakened during ebb tidal current, and the stratification was mainly maintained by depth-mean straining.

Keywords

mixing and stratification, potential energy anomaly equation, the North Passage of Changjiang Estuary, China, saltwater intrusion

O06.6

Environmental parameters of water and sediments and socio-economics of fishing communities around a tidal inlet in Pulicat Bird Sanctuary along the Coromandal coast of Andhra Pradesh, India

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Abstract

The stability of lagoon ecosystems is dependent on the proper functioning of tidal inlets which allow exchange of water and nutrients between the sea and lagoon. The closure of a tidal inlet along the south-eastern Coromandal coast of India has not only impacted the livelihood of local fisher communities but even the ecological balance of India's second largest brackish water lagoon, the Pulicat Bird Sanctuary in Andhra Pradesh. Owing to these concerns, we assessed the hydrological and nutrient parameters of water and sediment samples and the socio-economics of 252 fishers from 8 village clusters around a tidal inlet, situated at the northern section of Pulicat Bird Sanctuary. We recorded hypersaline conditions, high conductivity, high total dissolved solids and few freshwater indicator species in the lagoon. Fisher communities reported reduced availability of fish stock, increase in prawn culture and an overall dramatic change in fishing practices over the years. Almost 93% of the respondents were of the opinion that the opening of tidal inlet will increase fish stock in the lagoon, thereby reducing their travel time for fishing in the sea. Our findings showed that the opening of Rayadoruvu tidal inlet is necessary for stabilizing the salinity levels, increasing the diversity and abundance of planktons and fish in the lagoon and for long-term maintenance of the brackish water lagoon ecosystem in Pulicat Bird Sanctuary to support globally important migratory bird species and winter visitors of the Central Asian Flyway.

Keywords

Tidal inlet, Brackish water lagoon, Hydrological parameters, Biological nutrients

O06.7

Evolution of water quality in a large eutrophic european estuary under changing pressures: the Scheldt estuary since the nineties

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Abstract

The tidal freshwater Scheldt Estuary (Belgium), located in one of the most densely populated areas of Europe (over 500 inh./km²), is a highly eutrophic system currently recovering from hyper-eutrophication thanks to improved waste water treatment efforts.

Since 1996, the OMES project involves a multidisciplinary team of research groups (biologist, chemist, hydrologists, sedimentologists) performing monthly to bimonthly water quality monitoring documenting on the evolution of the estuary. Focusing on biogenic parameters, data analyses are performed with the aim to understanding the past, present and future major controls governing nutrient and trophic balance at ecosystem scale.

Results show that the ecosystem shifted from a respiration dominated system towards a more autotrophic system, causing a spectacular and rapid improvement of the water quality in the late nineties and early 2000's, especially documented by decreased dissolved inorganic N and P, increased oxygen and decreased CO_2 levels. Not only was this linked to reduced organic matter inputs to the estuary by increased wastewater treatment in the basin, increased primary production was also observed. However, for the past 10 years, no important further improvement was recorded. On the contrary, there are indications of a declining quality again. This time, water quality from the catchment is no longer the major problem. Important hydrodynamic and geomorphologic changes within the estuary itself seem to influence water quality. Altered residence times and a changing light climate can indeed strongly reduce pelagic primary production.

Keywords

Scheldt estuary, trophic status, oxygen, recovery

O07.1

Model based assessment of the reflection behavior of tidal waves at abrupt bathymetric changes in estuaries

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Abstract

Estuaries are often heavily modified by human activities. This includes the construction of storm surge barriers, dikes and other flood protection measures as well as the construction of ports or repeated adjustments (deepening) of navigation channels (fairways) to ports. These modifications lead to a change of the tidal wave in estuaries. The estuaries are more or less channelized and damping of the tidal wave may be reduced which leads to a stronger incoming tidal wave. Shoaling of the tidal wave leads to an increase of tidal range, and, in addition, reflection of the incoming tidal wave occurs at abrupt bathymetric changes (bottom steps, widening / narrowing of cross-section, etc.) which also amplifies the tidal range. The influences of these processes on a complex tidal regime in estuaries where dozens of partial tides are overlaid are not fully understood yet.

In order to improve the understanding of the reflection of tidal waves in estuaries, reflecting features in estuaries are systematically investigated and reflection coefficients at main reflecting features are determined based on i) analytical model approaches and ii) hydrodynamic-numerical (HN) modelling. In the context of this research the HN-model is very much simplified and basically consists of a long tidal channel. In the model a clear separation of the incoming and reflected wave generated by an abrupt bathymetric change can be seen (Figure 1). Various reflecting features are applied into the HN model to determine the respective reflection coefficients.

First results show a high agreement in the results of the two model approaches. With the simplified model assumptions reflection coefficients at abrupt bathymetric changes can be parameterized and specified.

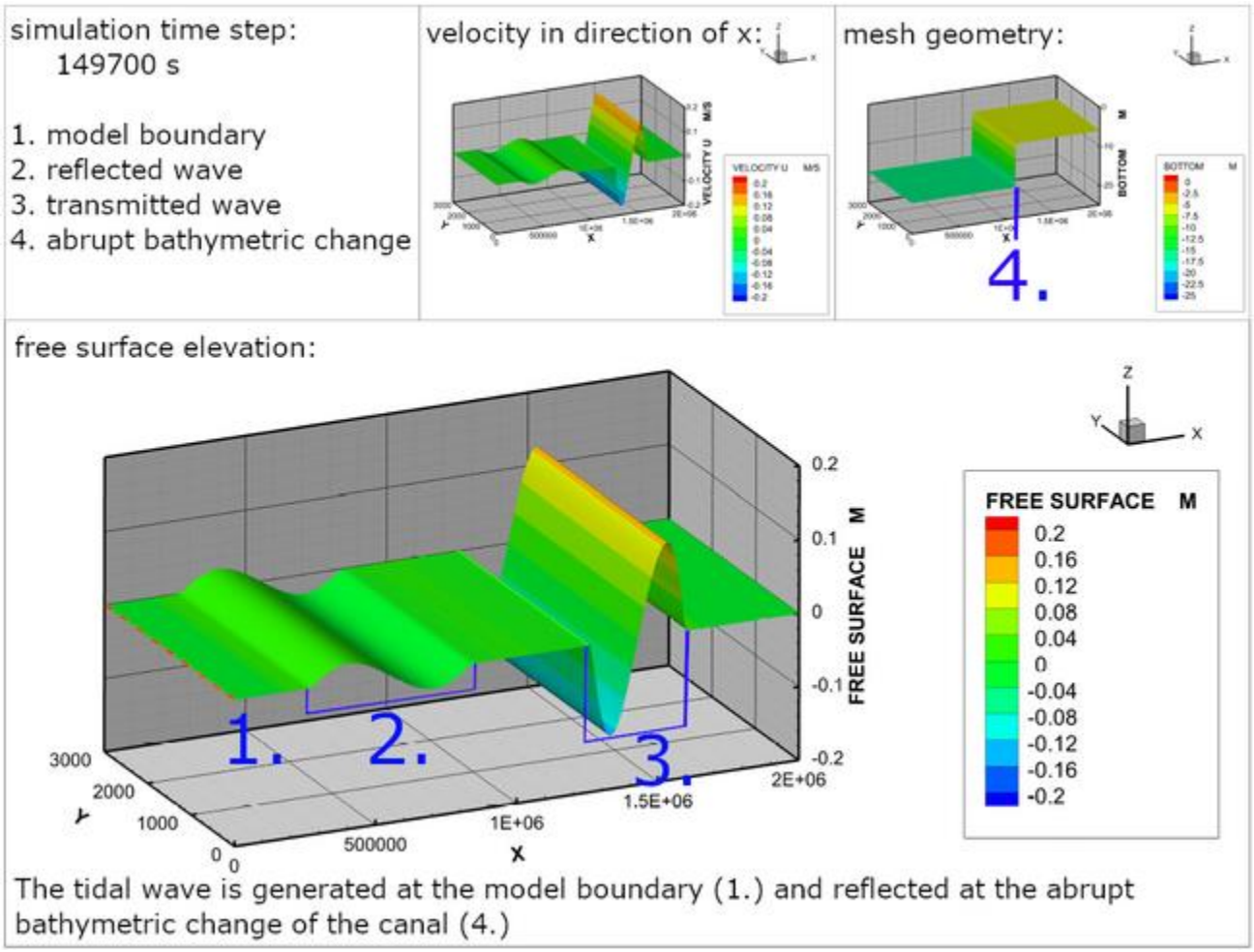

Figure 1: Results of an HN-simulation (time step 149700s) showing the reflected and transmitted tidal wave in a simplified hydrodynamic-numerical channel model simulated with TELEMAC2D.

Keywords

analytical model, hydrodynamic numerical modelling, reflection, tidal wave

O07.2

Tidal amplification in reflection influenced estuaries – partial tide differentiated examinations

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Abstract

Estuaries are subject to natural variations and anthropogenic measures, often leading to significant changes in estuarine tidal oscillation. Various river engineering measures have established tidal wave reflection at cross-sectional constrictions in the Elbe estuary in the Port of Hamburg and at the weir, and have increased the tidal range in the Elbe estuary over the past century. Between 1990 and 2010, the tidal range rose about 0.75 cm/a. From 2011 to 2017, the gradient was with 2.8 cm/a almost four times greater, although the last major river engineering measures occurred 2000 (deepening) and 2004 (tidal space reduction) (Figure 1).

Although many studies were conducted investigating the tidal wave transformation in estuaries, studies based on spatially well-distributed empirical data covering periods over more than a year are rare. To develop a better understanding of estuarine tidal oscillation with reflection induced formation of partially standing waves in anthropogenically modified estuaries, we analysed the partial tides specific oscillatory behaviours. For this purpose, a harmonic analysis method of least squares was applied to 22-year hydrographs of 25 gauges distributed across the estuary.

The tidal constituents' oscillatory behaviour including the formation of reflection induced partially standing waves were determined (Figure 2). The tidal constituents exhibit common frequency group-specific partial clapotis. As reflection can cause resonance in tidal influenced rivers, tests were developed to analyse whether criteria for resonance are met and the system specific resonance frequency was determined. Furthermore, dependencies of the tidal oscillation on influencing factors such as river discharge and morphological changes were investigated.

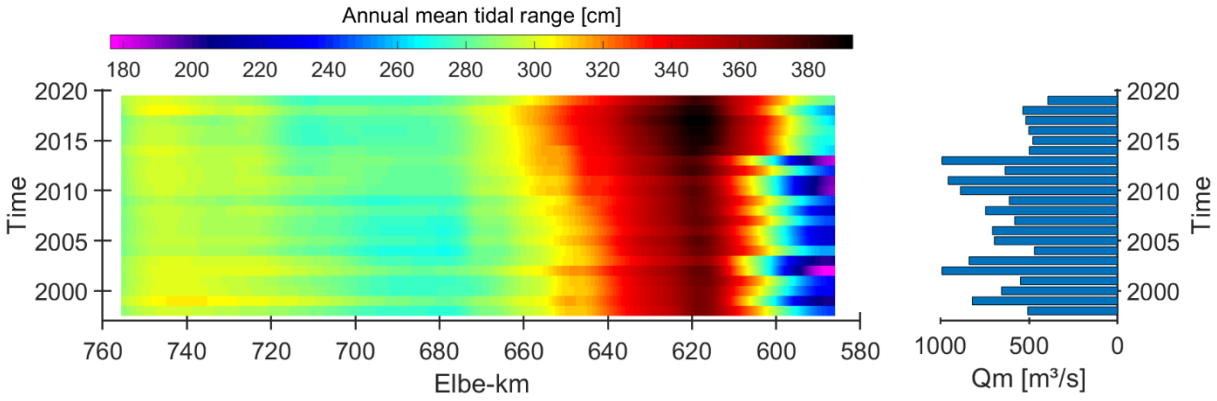

Figure 1: a) Overview of tidal ranges inside the Elbe estuary. b) Yearly mean river runoff (Qm).

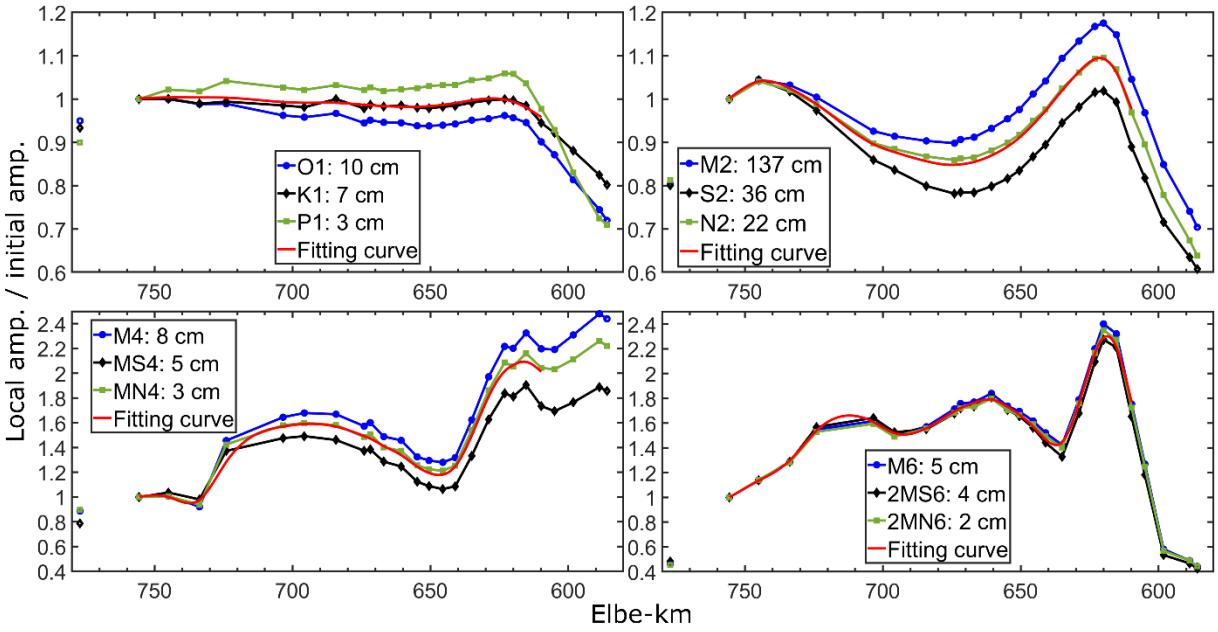

Figure 2: *Wave forms of a) diurnal, b) semidiurnal, c) quarter-diurnal and d) sixth-diurnal tides. Amplitudes normalized to incoming amplitudes (legends). Hein et al. (2021)*

Keywords

estuarine tidal amplification, tidal constituents, tidal reflection, tidal resonance

O07.3

Interactions between estuarine suspended particle dynamics and biology: a model study

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Abstract

Aggregation plays an important role in suspended particulate matter (SPM) dynamics. Effects of physical drivers on aggregation rates and SPM dynamics have been extensively studied. However, the interactions between biological processes and SPM dynamics are less well understood. This is especially true for estuaries, where aggregation is often dominated by lithogenic particles.

Biological factors influence the SPM dynamics by favoring less dense but larger aggregates, and by increasing the aggregation efficiency. Aggregation typically enhances settling and decreases SPM concentration. This drawdown of SPM concentration in turn critically affects the light environment for biological processes.

In this study, we investigate the two-way interactions between biological factors and aggregation of SPM in a numerical model. The model is applied and validated by test cases from lab studies and field observations from estuarine systems. Our results point to a realistic simulation of highly variable SPM dynamics at a tidal scale, mediated by changes in shear stress.

Simulations for different seasons point to a possible positive feedback between aggregation rate and phytoplankton growth. Sticky organic particles excreted by phytoplankton enhance aggregation rate and settling, leading to a higher light availability. As light is the limiting factor for primary production in a turbid estuary, a better light environment promotes the growth of phytoplankton and the production of organic particles. This feedback can explain observed strong seasonality in estuarine SPM dynamics, in addition to physical drivers. We conclude that estuarine SPM management cannot be decoupled from water quality management, as both aspects are tightly interlinked.

Keywords

aggregation, suspended particulate matters, estuary

O07.4

Historic developments of the Ems Estuary – synergies between numerical modeling and observations

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Abstract

The Ems Estuary represents a tidal river in north-west Germany which is strongly characterized by density differences and a pronounced occurrence of fluid mud. The natural river has changed constantly over time. Since the beginning of the 20th century, these changes are dominated by operations such as dredging, dumping and straightening. The amount of suspended sediments within the Ems Estuary has increased significantly due to anthropogenic influences, while at the same time the issue has moved into the focus of public and scientific communities.

Historic developments of the Ems Estuary are modeled in order to investigate reasons for the development and increased propagation of fluid mud in the estuary. The 3-dimensional numerical model UnTrim is used for scenarios from the 1950's, 1981 and 2015, investigating influences of the bathymetry, bottom roughness and sea-level rise. The modeling of hydrodynamics is well established while other parameters pose a challenge to the modeler. Therefore, the evaluation of hydrodynamic parameters and the connection to turbidity and salinity give valuable insight into the development of the estuary and lead to a better understanding of the processes behind the so-called regime-shift.

Additional investigations of long-term observations measured at gauge stations along the Ems Estuary allow for trend analyses of near-surface salinity. Due to positive linear trends, which accelerate up-estuary, we assume enhanced transport of saline water further up-estuary. This observation is in good agreement with the model results. To further examine the outcome of the numerical model this study investigates the correlation between the increase of salinity and the changes in tidal range along the estuary.

We will present the synergies between the observations and the numerical model results and discuss preliminary results of further numerical model analysis.

Acknowledgement: Partly funded by the German Federal Ministry of Education and Research (BMBF), project: MudEstuary (03KIS113).

Keywords

anthropogenic influence, salinity, numerical model, Ems Estuary

O07.5

Does sediment transport depend on the vertical force in estuarine and coastal flows?

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Abstract

Tidal bores are sudden discontinuities in water depth, and can be classified as undular and breaking bores when tidal waves propagate upstream in a river mouth and on beaches. The impact of different types of forces under bores on sediment transport is not clear, hence specially designed experiments were conducted to clarify the mechanism of sediment initiation, although some physical experiments were performed during the last two decades. In wave condition similar to a steady flow, all the previous studies had used averaged lift force to understand the mechanism of incipient motion. In this study, a laser Doppler anemometer, a highly sensitive force sensor, and ultrasonic displacement meters accompanied by video recordings were used to investigate simultaneously the incipient motion of sediment under tidal bores. No sediment motion was observed during the initial steady flow, but a transient sediment sheet flow motion was observed advected upstream during the breaking bore, however, only a few particles changed their initial position during the undular bore. Visual observation demonstrated two different stages of sediment movement that phenomena were also verified with the measured observations. According to the experimental results, upward vertical force due to swelling in free water surface (stage 1) before the roller toe was the main force in destabilizing the particles. Later, a large upstream longitudinal force was found to be the dominant cause promoting upstream particle motion during the breaking roller passage (stage 2). Furthermore, phases of both horizontal and vertical forces play an important role in tidal bore propagation. It is interesting to note that by using the measured force, the observed phenomenon can be well explained by the Shield threshold criterion.

Keywords

Tidal bore, Hydrodynamic forces, Incipient motion, Physical modelling

O07.6

Model-based method for robust prediction of changes due to channel adaption measures in the Weser Estuary, Germany

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Abstract

Societal awareness for the environmental impact of human intervention attended by strict approval procedures has raised the need for robust predictions. These have to be conservative (safe side) and indicate the intensity and the spatial extent clearly. Especially for estuaries a precise prediction for the effect of single adaption measures is not trivial due to the high natural variability. Changes are typically quantified with numerical models. The results include uncertainties and thus may not be conservative, which makes further evaluation necessary.

For the prediction of hydrodynamic changes modelled key parameters (water level, velocities and salinity) are analysed. A representative year is selected to consider the seasonal variation. A validated 3D-estuary model is used incorporating baroclinic circulation. The employed hydrodynamic modelling tool is UnTRIM. Model runs for the given and the correspondingly adjusted state are executed. The differences of determined tidal characteristic numbers are further evaluated statistically and confidence intervals are determined. Based on the corresponding quantiles and defined thresholds conservative predicted values are derived eventually.

The application for the Weser Estuary (Germany) shows the appropriateness of this method: For example, the deepening of a 35-km reach in the outer estuary to a continuously navigable depth from 14 to 15 m by a dredging depth of max. 1 m would lead to a (conservatively) predicted increase of the subtidal salinity of 1 ppt for a 40-km zone at the mid estuary.

The robustness of the method crucially depends on the scope of the model. The simulation time is still an arbitrary choice in terms of selected year and total time span, but reflects common conditions. Besides, variation on longer scales might be not encompassed. Furthermore, the definition of the threshold values is crucial for the predicted extent of the effect and has to consider all potentially affected environmental issues.

Keywords

prediction method, dredging impact, estuary, numerical model

O07.7

Suspended particulate matter observations in the Belgian Scheldt Estuary as part of OMES monitoring program.

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IMDC, Belgium

Abstract

Along and in estuaries a lot of activities are taking place. To determine the impact of the major activities on the estuarine ecosystem in the Scheldt Estuary (Belgium), a monitoring and research program has launched in 1995, called OMES. The OMES project aims to extend the biogeochemical knowledge of the Scheldt Estuary. Monthly campaigns have set-up to observe the long-term effects along the Belgian Scheldt Estuary on the basic water quality, carbon cycle and Suspended Particulate Matter, phytoplankton and phytobenthos, primary production and Zooplankton.

This presentation will focus on the Suspended Particulate Matter observations obtained during OMES-program. An overview will be given of the monitoring set-up of the latest 5 years, measuring techniques, results and analysis.

Keywords

sediment, monitoring, estuary

O08.1

From the Landslide to the Coast; Thai-coast: an integrated project research looking at the links between Sediment Mobilisation in Upper Catchments to its Redistribution on the Shoreline under the Pressure of Climate Change in Thailand

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Abstract

In Thailand erosion and flooding affect more than 11 million people living in the coastal zone. The Ministry of Natural Resources and Environment of Thailand has calculated that each year erosion causes a loss of 30 km^2 of coastal land in the country and predicts that sea level rise will impact at least 3,200 km^2 of coastal land, through erosion and flooding. This study aims at investigating the link between sediment availability from 6 river catchments in the south of Thailand and the coastal evolution directly downdrift of their mouth.

Because of the large spatial area of the study, landslide event and coastal erosion data analysis was undertaken using remote sensing methods (aerial photographs and satellite imagery). Most of the data collection and processing was done through automated machine learning tools utilising Google Earth Engine. This methodology has the advantage of rapid computing of large a datasets. Thus, 20 years of data at various time scales (sub-daily, seasonal and yearly) and resolutions (sub-metric to 30m) were processed between 2000 and 2019 in a matter of days.

Additionally, core samples taken in the mangroves near the river mouths were used to identify markers of landslide events and associated sediment cascades based on grain size distribution and ^{210}Pb dating.

Preliminary results show that coastal mangroves are much more dynamic than sandy beaches with evolution rates respectively ranging from up to -70 m/year to 21.7 m/year and from -21.2 m/year to 7.9 m/year. Generally, coastal environments on the Andaman Coast are much less dynamic than those on Gulf of Thailand coast.

Grain size analysis shows variations of the D_{50} throughout the sediment recordings indicators of landslides and rainfall events. ^{210}Pb dating allows for temporal calibration of the sediment records.

Keywords

Sediment transport, Landslide, Coastal Change, Climate change

O08.2

DANUBIUS-RI: International Centre for Advanced Studies on River-Sea Systems

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Abstract

DANUBIUS-RI, the International Centre for Advanced Studies on River-Sea Systems, is a distributed research infrastructure (RI) integrating studies of rivers and their catchments, transitional waters such as estuaries, deltas and lagoons, and their adjacent coastal seas. The overall aim is to support the sustainable management of River-Sea Systems by (1) providing access to facilities, methods and tools, as well as samples and data; (2) bringing together relevant expertise to facilitate interdisciplinary research, advance process and system understanding and enhance stakeholder engagement; and (3) enabling the development of integrated management and policy-making in River-Sea Systems. In 2016, the European Strategy Forum for Research Infrastructures (ESFRI) included DANUBIUS-RI in its roadmap highlighting the need for a research infrastructure at the freshwater – marine interface.

DANUBIUS-RI's Science & Innovation Agenda is guiding the RI's evolution as it progresses from preparation through implementation to operation. It describes DANUBIUS-RI's vision, mission and approach, and provides a scientific framework for the RI's design by highlighting key research priorities for the first five years. The framework includes interrelated key challenges in River-Sea Systems, such as global change, the quantity and quality of water and sediment across the river-sea continuum as well as the structure and functioning of associated ecosystems.

DANUBIUS-RI is composed of a Hub, Data Centre, Technology Transfer Office, E-Learning Office, Nodes and Supersites. Nodes provide state-of-the-art facilities, interoperable methods and expertise regarding Observation, Analysis, Modelling and Socio-Economic Impact. Supersites provide access to study sites covering a whole River-Sea System or several sites within a River-Sea System and a range of River-Sea Systems along climatic, environmental and socio-economic gradients across Europe. This enables researchers to study the functioning of these systems, to assess impacts and risks from various human activities, as well as to develop and test potential measures to address common and emerging challenges.

Keywords

research infrastructure, river-sea systems, global change, ESFRI

O08.3

Reconstructing changes in sediment flux in the Danube-Black Sea System

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Abstract

One of the global changes affecting River-Sea Systems is the reduction of sediment flux, a direct consequence of human interventions in the river basins. The deltas, especially, record the most striking effects, coastal erosion and habitat degradation. This research assesses the change of sediment flux from the Danube though its Delta into the Black Sea, using time series analysis of water and suspended sediment data, sediment profiling of ^{210}Pb and ^{137}Cs, and information from Earth Observation. Effects at time scale of decades - up to a century - as well as changes in seasonal variations are identified.

The results show changes in both general trends and seasonality of water and sediment flux of the Danube, as a consequence of climate change and input of dams. The Danube Delta complex records variable sedimentary rates, from the sub-aerial delta to the prodelta area, increasing in certain area and decreasing in others. The variations within the subaerial delta are controlled mainly by hydrological connectivity, while the variations within the subaqueous delta are controlled primarily by coastal jetties, proximity to river mouth and the evolution of the river plume. Seasonal variations of suspended sediment are largely controlled by the same factors, in addition to local phenomena (e.g. bottom sediment resuspension) and the seasonality of water primary productivity.

The results shed new light on the impact of sediment starvation in the Danube Delta and its coastal zone and the potential impacts these different environments might face. The results could contribute to development of methodologies for monitoring environmental change in a collective transboundary management system of the Danube catchment, which could be applied in other River-Sea Systems around the world.

Keywords

River-Sea Systems , Sediment flux , Danube-Black Sea System

O08.4

Connecting an integrated environmental assessment with stakeholders' perceptions on the land-sea social ecological system of SW Messinia, Greece

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Abstract

Coastal areas exhibit some of the most complex dynamics in terms of coupled social-ecological systems and associated uncertainties for sustainable planning. These are the spaces where the land meets the sea and where human communities depend on the land and/or the sea. Conventional management approaches often lack in their inclusion of social concerns and values, or focus on the narrow strip between land and sea. Therefore, treating off-shore and upstream activities as external pressures limiting the ability to holistically respond to underlying complexities. A social-ecological systems approach along the land-sea continuum, such as that applied here, combines the knowledge gained from the social and natural sciences, with the knowledge of those living and working with this interconnectedness. This dynamic systems perspective increases the understanding of ecological and social interactions that inevitably put pressures on the environment. Data collection included sampling fieldtrips in small streams, transitional waters (Gialova Lagoon, Natura 2000 site), and the coastal area, in order to assess the potential anthropogenic impact. During the same period, several stakeholder workshops took place focusing in combining local knowledge and perceptions through mind mapping participatory methods and fuzzy cognitive models. The environmental assessment did not reveal extensive degradation on the coastal or the riverine environments, as most sampling areas, were classified in 'Good Ecological Status'. However, it did reveal increased pressures on the coastal wetland ecosystem (eutrophication, salinization, habitat loss). These pressures, which result to degradation of wetland ecosystem services (e.g. fish provision, water circulation and purification, support of biodiversity), were connected to past and current anthropogenic activities by the stakeholders. The holistic understanding about the interactions gained through the stakeholder workshops, showed that the dynamic nature of social practices and values, could increase or lessen environmental impacts depending on the recognition of this interconnectedness in future planning and policy decisions.

Keywords

Social ecological systems, holistic planning, coastal governance, knowledge sharing

O08.5

Investigating the resilience of coastal ecosystems to changes in climate and land management

Naomi Greenwood, Michelle Devlin, Liam Fernand, Lenka Fronkova, Jennifer Graham, Carolyn Graves, Richard Heal, Henry Liu, Roi Martinez, Paulette Posen

Cefas, UK

Abstract

Liverpool Bay, in the eastern Irish Sea, receives inputs from numerous rivers draining agricultural land and large population centres. Inorganic nutrient concentrations are elevated in the region with respect to thresholds set under the Water Framework Directive and OSPAR assessment frameworks, and nitrogen to phosphorous ratios have steadily increased over the last 25 years. Changes in the phytoplankton community structure have been observed, with potential negative impacts on the marine food web.

In this study we used a combination of remote sensing, catchment and coastal modelling and in situ water quality monitoring data to determine the impact of river plumes on the coastal ecosystem under current day conditions and altered climate and land use scenarios. The current spatial extent of the river plumes was determined by deriving and mapping the Forel Ule colour scale, as determined from Sentinel-3 satellite imagery, and application of a high-resolution FVCOM coastal model. Seasonal variability in the river plume extent and associated water quality was observed, corresponding to changes in the river discharge.

A SWAT catchment model was used to simulate the impact of changing land use (as currently being considered under the Environmental Land Management Scheme in the UK) on nutrient and sediment loads from river catchments into the coastal zone of Liverpool Bay. Modelled conversion of agricultural grasslands to transitional woodland and the expansion of existing wetlands through conversion of agricultural grasslands both showed potential for reducing the impact of agricultural activities on riverine water quality.

The tools developed in this study facilitate an integrated assessment of catchment to coastal ecosystem changes from anthropogenic pressures. The framework presented will allow us to better understand, measure and advise on the cumulative impacts of changes in climate and land use on coastal and marine ecosystems.

Keywords

coastal, river, nutrients, plume

O08.6

Modelling the eutrophication reaction chain along the Elbe River-Estuary-Continuum (Germany) by highlighting the role of zooplankton

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Abstract

The Elbe estuary is loaded by high input of algal biomass from the highly productive middle reach of the river. In the Hamburg Harbour area located in upper freshwater part of the estuary, a strong decline of algal biomass can be observed. Along with degradation of algae biomass and the lack of oxygen production, a strong depletion of oxygen lowers the ecological state of the Elbe estuary dramatically. The mechanistic water quality model QSim of the German Federal Institute of Hydrology was applied to simulate algal growth and decline along the Elbe river estuary continuum of about 725 km. Based on different hydrodynamic drivers, 1d model HYDRAX for river section and 2d model UnTrim² for the estuary, the water transport and resulting water age was determined. For validation measured long term data of nutrients, chlorophyll, oxygen and zooplankton as well as longitudinal profiles of theses parameters are compared with the model results. By analyzing the different processes of the phytoplankton growth and die off, the strong influence of zooplankton grazing becomes obvious not only for decrease of algal biomass, but as well as for carbon transfer from algal biomass to dissolved carbon compounds, which are degradable for heterotrophic bacteria.

Keywords

water quality model, eutrophication, phytoplankton, zooplankton

O09.1

Quantifying seasonal movement overlap of mobile demersal fish species in a subarctic coastal marine protected area

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Abstract

The Gilbert Bay Marine Protected Area (GBMPA) was established in southern Labrador, Canada primarily to conserve a locally adapted and genetically distinct inshore population of Atlantic cod (*Gadus morhua*) and associated habitat. Despite this designation, monitoring efforts have demonstrated a substantial decline in the GB Atlantic cod (GB cod) population, largely attributed to fisheries removals at MPA boundaries. In addition to sustained fishing pressure, changes in fish community assemblages also threaten GB cod, increasing vulnerability to further reduction. We investigated local fish species interactions and habitat use within the GBMPA using acoustic telemetry to document seasonal movement patterns of GB cod, Atlantic cod from offshore populations (offshore cod), and Greenland cod (*Gadus macrocephalus ogac*). Fish implanted with acoustic transmitters were released within a passive acoustic array of receivers positioned throughout the MPA and contiguous marine waters, enabling monitoring of fish movements over a 3-year period. Additionally, we used substrate and bathymetry information derived from multi-beam sonar surveys to delineate habitat throughout the MPA. GB cod, offshore cod, and Greenland cod movements overlap during summer, with less pronounced overlap during winter. The area of summer overlap was primarily concentrated seaward, along the MPA boundary, where GB and Greenland cod mixed with offshore cod. In winter, while GB and Greenland cod moved inshore within the MPA, offshore cod were virtually absent. These residency and habitat use patterns likely relate to the availability of foraging habitat during the summer, and spawning/overwinter habitat requirements of each group during the winter and spring. Our study identifies important refuge habitats for GB cod and areas where there is potential competition with other local species. These data help us understand the important factors contributing to GB cod decline and can aid in refining management practices to accommodate seasonal movements and protect this species of conservation concern.

Keywords

acoustic telemetry, seasonal movement, habitat use, Marine Protected Area

O09.2

Study of microphytobenthic primary production using an automated photosynthesis-energy curves acquisition in a laboratory climatic chamber

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Abstract

Over the last decades, estuarine ecosystems have been subjected to anthropogenic pressures due to extensive industrial development, coastal development, dredging activities and land reclamation. Among the different facies that make up estuaries are mudflats, which are environments that promote the growth of dense biofilms of microphytobenthos (MPB). These MPB biofilms allow and control fluxes between the sediments and the water column, stabilize the sediments, can contribute up to 50% of estuarine primary productivity and are important food sources forming the basis of major estuarine food webs.

Despite numerous studies, the knowledge of the spatial distribution and production processes of MPB remains scarce because measurements of production processes are very time-consuming. Consequently, this study presents the development and functioning of a fully automated system for the measurement of oxygen microprofiles, allowing to acquire P-E curves with a large number of replicates. Sediment cores are sampled in the field and, back to the laboratory, they are placed in a laboratory climate chamber to control temperature, hygrometry and illumination. With only two electrodes, over a period of 24 hours, it was possible to record about 260 profiles automatically without any human intervention, under increasing illumination from 0 to 1700 µmol photons.m^{-2}.s^{-1} (22 different light intensities being applied to the MPB). The automation of the system allowed to obtain a large data set leading to the creation of accurate photosynthesis-energy (P-E) curves.

Such an automated system was used to create numerous P-E curves in order to investigate the temporal and spatial variability of MPB primary production in a macrotidal estuary (Canche estuary, Opal Coast, France). For this purpose, primary production of MPB was studied on different biofacies along the salinity gradient, with numerous replicates. We were able to measure a net production ranging from 0 to 7mmol O_2.m^{-2}.h^{-1}.

Keywords

Microphytobenthos, Oxygen flux, Photosynthesis-energy curves, Automation

O09.3

Testing the utility of marine habitat classifications as biodiversity surrogates

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Abstract

Habitat classifications define habitat types that act as surrogates for biodiversity patterns. These classifications may be derived from actual data or expert opinion and may include environmental variables and/or biological variables. The aims of this study were firstly to determine the validity of a data-derived seascape and an expert-derived habitat classification on the west coast of South Africa; secondly to compare the performance of these classifications to each other and against a classification that was based on both biological and abiotic data (biotopes); and lastly to determine the best classification. The Canonical Analysis of Principal Coordinates (CAP), a constrained ordination, was utilised to determine whether the macro-infaunal assemblage of each sample was consistent with the assigned habitat in each classification. The fit of each habitat classification with the macro-infaunal data was measured as allocation success. Both the seascapes and expert-derived habitats had high allocation success, however, the expert-derived habitat classification (93-94 %) performed marginally better than the seascape classification (89-92 %). These two classifications also performed well compared to the biotope classification (98 %). This study indicated that there is a trade-off between capacity requirements and cost, and the performance of habitat classification systems as surrogates of biodiversity patterns. For unconsolidated sediments on the South African west coast, the seascape and expert-based habitat classifications were good surrogates most likely due to the inclusion of the most important environmental variables and the comprehensive understanding of the ecosystem processes in the region. Whether this extends to other ecosystems should be tested. It is recommended to start with seascapes and progress through expert opinion to biological data-driven habitat classifications as data availability increases to continually improve the utility of habitats as surrogates for biodiversity.

Keywords

ecosystem classification, surrogates, seascape, biotope

O09.4

Spatio-temporal distribution of benthic macrofauna of the large fluvially dominated Kei Estuary, South Africa in response to a flood.

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Abstract

Physical disturbances because of floods and drought are key determinants of the spatial and temporal dynamics of benthic habitat and associated biotic communities of rivers and estuaries. Floods may result in reduced benthic diversity and abundance since both burrowing and epibenthic species have the potential of being washed away. The objective of this study was to investigate the effects of a flood on the macrofauna of a fluvially dominated estuary. The Kei estuary was sampled bi-annually from 2016 – 2018, the February 2018 sampling coinciding with a flood event. A total of 38 species were recorded during the sampling period. The estuary was dominated by the amphipod, *Grandidierella lutosa* and the polychaetes, *Prionospio sexoculata* and *Desdemona ornata* throughout the sampling period. Densities of *G. lutosa* and *D. ornata* increased substantially after the flood. Maximum densities recorded for *G. lutosa* were 2 461 ind. m^{-2} before, 112 ind. m^{-2} during and 9 005 ind. m^{-2} after, the flood respectively. Similarly, maximum densities recorded for *D. ornata* were 1 323 ind. m^{-2} before, 0 ind. m^{-2} during and 4 336 ind. m^{-2} after, the flood. However, overall, higher species diversity, richness and abundance were observed during the low-flow rather than the high-flow season. Changes in diversity, richness and abundances during and after the flood are consistent with trends observed in similar studies.

Keywords

Flooding, Macrofauna, Benthic

O09.5

Tracking *Pinna nobilis* population status and structure after a mass mortality outbreak through a rapid and cost-effective protocol

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Abstract

The largest Mediterranean bivalve, *Pinna nobilis* is being severely threatened by a disease that is causing a drastic Mass Mortality Event (MME) which is pushing the species to the brink of extinction. Population size reduction, due to MME was estimated at over 80%, and *P. nobilis* entered the IUCN Red List as critically endangered species in 2019. For the first time, we investigated *P. nobilis* population, on a large geographical scale (400 km) along the Italian coast. An innovative, rapid, and cost-effective standardized protocol was developed in order to assess *P. nobilis* population status and structure across habitats. The survey investigated sixteen areas off the Apulian coast for a total of 96 transects and an overall length of 48 km. Scuba divers were equipped with head strap cameras in order to record high definition video along each transect. The transects were marked by a 500 m rope labeled every 10 m and GPS tracked. From each video, *P. nobilis* specimens were counted progressively and the rope labels allowed georeferencing both specimens and habitats, thus obtaining data about both targets.

Survey data allowed to assess the mortality rate and to evaluate densities and size distribution among habitats, bathymetries, and hydrodynamic expositions before the MME. A 100% mortality rate was detected evidencing the drastic effect of the MME along the Apulian coast. Hydrodynamics exposition emerged as the main stressor affecting *P.nobilis* distribution since the bulk and largest specimens were distributed in the deepest and most sheltered areas.

Further large-scale studies with standardized protocol need to be carried out, in order to get an overall picture of the status of *P.nobilis* in the Mediterranean basin. Indeed, these data are critical to develop future coordinated actions and to introduce basin-scale measures in order to preserve or restore this valuable species.

Keywords

Pinna nobilis, Monitoring program, Population structure, Mass Mortality Event

O09.6

Role of zooplankton in feeding of the White Sea threespine stickleback in a period of warming Arctic

Anna Demchuk, Mikhail Ivanov, Tatiana Ivanova, Danila Melentev, Natalia Polyakova, Dmitry Lajus

St. Petersburg State University, Russia

Abstract

Threespine stickleback Gasterosteus aculeatus population in the Arctic White Sea significantly grew during the last two decades and turned out from the rare to the most abundant species due to increased temperatures. Now it comprises about 95% of all fish in inshore area during summer period. Their massive inshore migration in early summer drastically change trophic chains of coastal communities. Thus, studies of feeding are needed to better understand the structure and functioning of ecosystem. Juvenile stickleback during the first weeks of their life feed on both benthos and zooplankton. Among the latter are copepods Temora longicornis, Microsetella norvegica and ciliophora Helicostomella subulata. Spawning adults feed in inshore zone mostly on benthos and stickleback eggs and on some zooplankton. Very limited data on offshore feeding shows that before spawning, adults feed on such zooplankton taxa as copepod Calanus glacialis and Euphasiidae varia, whereas youngs of the year feed on zooplankton taxa with dominance of cladoceran Podon leuckarti. In inshore zone, the stickleback diet well correlates with composition of zooplankton in the sea, but offshore the correlation is weaker and food organisms dominating in stomachs may be rather rare in the sea. We noted this for P. leucarti, C. glacialis and euphausiids. This shows that the stickleback may quickly change their position depending on presence of preferable prey. Therefore, stickleback exhibits very plastic feeding behavior quickly establishing multiple trophic links with high variety of organisms and hence interlink inshore and offshore communities. High phenotypic plasticity allows this species to adapt to different environments and facilitates its quick population growth. The study was supported by RSF grant 19-14-00092.

Keywords

threespine stickleback, White Sea, zooplankton, climate change

O09.7

Ecological study on the soft-bottom macrobenthos in the transitional waters of Rječina, Jadro and Neretva rivers (Adriatic Sea, Croatian coast)

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Abstract

Present study is a part of comprehensive research within National WFD monitoring of Transitional Waters (TW) in Croatia. It refers to the soft-bottom macrobenthos from the selected TWs situated along the eastern coast of the Adriatic Sea (AS), i.e. Rječina (northern AS), Jadro (central AS) and Neretva (southern AS) TW. All sampling sites were situated in areas of diverse anthropogenic pressures, including moderate urban and industrial pollution, maritime transport and port activities. Sampling was performed during 2016-2019 campaign, using Van Veen grab (0.1 m^2). Preliminary separation of macrofauna was performed on board, by rinsing of the sediment on the 1 mm mesh sieves. Additional samples were taken for sediment analyses: ORP, organic matter and granulometric composition of sediment. The material retained on sieves was fixed with 4% seawater solution of formaldehyde and then processed after standard laboratory procedure: complete separation, sorting, counting and taxonomic identification of macroinvertebrates. The results of qualitative and quantitative, structural and functional analyses (taxonomic composition, abundance, species richness, diversity, functional composition) are provided. Statistical analysis of communities' structure and analysis of the Ecological Quality Status were performed using Primer V software and AZTI application and database. At all sites, macrobenthic communities were characterized by predominance of Annelida and Mollusca, that together comprised 77-94 % of total macrofauna. The abundance and number of species were close at all sampling sites, but they differ in species composition. In the research area, Ecological Quality Ratio (EQR_{AMBI}) based on the Biological Quality Element (BQE) benthic invertebrates indicated moderate to high Ecological Quality Status. However, TWs are naturally stressed environments, inhabited by species adapted to stress conditions. Until now, there is no adequate methodology for distinction of natural and anthropogenic impact on the macroinvertebrates in TWs. In this regard, further research is needed.

Keywords

macrobenthos, transitional waters, community structure, Adriatic Sea

O09.8

Combining metagenomics with morphology-based approaches to understand microbiome –meiobenthos interactions

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Abstract

Sediment microbiome has an essential role in regulating ecosystem functions, not only regulating primary productivity and nutrient cycling but also shaping trophic interactions with higher trophic levels. While the importance of microbiome in terrestrial soil systems is highly recognized, its role in marine aquatic environments remains much less studied. Microbiome can be highly affected by bottom up (abiotic factors) and top down (predation by meiofauna) effects. Understanding the interaction effect between abiotic and biotic factors on microbiome communities will be an essential step for future predictions of ecosystem stability. To address this knowledge gap we studied the interactions among microbiome diversity and nematode communities in highly heterogenous Sado Estuary, SW Portugal. The samples were taken from three contrasting sites with varying sediment characteristics and human impact degrees. From each site, three replicate samples for sediment characterization (total organic matter, granulometry, total C and N), microbiome (*sensu lato*) and nematode community were taken. Total DNA from sediment was extracted using DNeasy Power Soil kit® (MOBIO, Qiagen) and processed for Illumina MiSeq platform sequencing targeting the V3-V4 region of 16S rRNA gene. Sediment characterization indicated heterogeneity between sites with distinct levels of contamination, which resulted in contrasting microbial communities. All sites showed a high α-biodiversity with predominance of Proteobacteria phylum, particularly Woeseiaceae, Desulfobacteraceae and Rhodobacteraceae families. Beside this heterogeneity in microbiome community, β-diversity was demonstrated to be very high, greatly discriminating among all three sites. Nematode composition and abundance followed a similar pattern as microbiome highlighting influential role of sediment characteristics. Combining abiotic sediment characteristics with metagenomics and morphological identification of higher trophic level communities might certainly contribute to the understanding of complex benthic interactions in marine ecosystems.

Keywords

Sado estuary (Portugal), Microbiome, benthic Nematodes, Metagenomics

O10.1

Resilience of the world's coastal land areas at the pursuit of tackling escalating pressures and vulnerabilities with increasing adaptive capacity

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Abstract

Introduction

Embraced by the opportunities of both land and ocean, coastal areas allure expanding human populations and associated economic activities. Often those are particularly prominent in terms of human and economic development as well as income opportunities. At the same time, they face growing climatic and environmental pressures due to climate change, degradation of both terrestrial and aquatic ecosystems, and expansion of built areas. The interface of sea and land area introduces impacts simultaneously from both the above catchment and the bordering sea.

Methods

We analyze the capacity of the coastal societies to cope with environmental and ecological vulnerabilities by using a geospatial social-ecological systems approach. Through the concept of resilience, we relate three key adaptive capacity factors (governance, economy, human development) to three environmental pressure factors (human footprint, coastal hazards, coastal marine pollution) from 1990 to 2015.

Results and discussion

The analysis reveals the increasing accumulation of people, particularly urban agglomerations, to coastal areas, and the subsequent land-use changes and environmental defies, both in vast dimensions. Our definition of coastal area entails a set of combinations of distance from the sea and altitude. Asian coasts have shown largest changes, and their expanding adaptive capacity is prodigious, allowing some growth in resilience despite of surmounting vulnerability. In North America and the Caribbean, changes have been more modest, but increasing vulnerability appears to defy the high adaptive capacity in many areas. The above-mentioned areas are particularly much exposed to hazardous events. The other coastal areas show less dramatic changes, but Africa's looming coastal crowding, paired with low growth in adaptive capacity raises resilience related concerns.

Keywords

Resilience, Coastal zone, Adaptive capacity, Vulnerability

O10.2

Spatiotemporal primary production and phytoplankton community behaviour in a highly dynamics and anthropized ecosystem: the seine estuary (france)

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Abstract

Estuaries system are particular dynamics system where the phytoplankton primary production varies considerably along the environmental parameter. This variation induce a need of high frequency sampling of the phytoplankton production in order to improve carbon budget understanding in those areas. In the eutrophic and temperate estuary of Seine (France), management policy have succeed in reducing the N input with the instant consequence of lowering chl a concentration.

Over a period of two years crossing of a 100 km distance of the estuary has been performed in the estuary to carry out spatial high frequency sampling of environmental parameter (temperature, oxygen, salinity, turbidity) and phytoplankton primary production using a fast repetition rate fluorimeter (FRRF-ACT2 chelsea technology, UK). In addition, low frequency sampling for investigation phytoplankton biomass, composition and nutrient need with chla a, flow cytometry (CytoSense, Cytobuoy, Netherland), Alkaline phosphatase activity measurements and nutrient (N, P, Si) were analysed.

First, our results reveal very high phytoplankton biomass (80 µg chl a.L-1) on a particular upstream point of the estuary similar to the concentration before the application of management policies. The phytoplankton composition varies along the crossing with pico-nano dominated population upstream followed by microphytoplankton-dominated population, and then picoplankton only dominated population. The high concentration is incidentally correlated with the high concentration of microphytoplankton in summer.

Overall, the maximum quantum yield of PSII (Fv/Fm) display stable value along the estuary, thus production is higher in the upstream part due to higher biomass. No N limitation are highlighted on the whole cross while P and Si concentration and their ratio partly influence estuarine phytoplankton dynamics and community structures. A proper evaluation of those drivers are required to help policy management targets.

Keywords

High frequency, primary production, phytoplankton , Flow cytometry

O10.3

A fuzzy cognitive map approach to understand the management of anthropogenic sandy shores in the Netherlands

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Abstract

Anthropogenic sandy shores (ASSH) are shores that are newly created or heavily modified by mega nourishments. Large amounts of offshore dredged sand are deposited at and near the shore, after which waves, wind, and currents spread the sand to reinforce the foredune for coastal safety, while wider beaches and lagoon features provide space for recreational activities and various habitats. Previous studies about ASSH mainly focused on understanding the biophysical system (morphology and vegetation), paying little attention to interaction with the social system on ASSH. This research aims to better understand the management activities and their interactions with user activities as well as the biophysical system on ASSH. A participatory modelling process is applied to better understand the management activities on ASSH based on first-hand stakeholders' knowledge, experience, and perception. First, semi-structured interviews with stakeholders from the management sector are conducted to collect information on each stakeholder's management activities and strategies on ASSH (past, present, and future), prevailing values, interests, aims, and interaction with other stakeholders and the biophysical system. Next, a workshop with identified stakeholders is organised to develop the management activities' conceptual model on ASSH by using the Fuzzy Cognitive Mapping method. In this workshop, the model's spatial boundary and principal components (e.g. management and recreational activities, recreational facilities, and biophysical elements (e.g. lagoon, dune, foredune, plants, and sand)), the interaction between stakeholders, the interaction between management activities and uses as well as the biophysical system are defined. It is the first time that the ASSH social system is analysed in this way. The developed conceptual model of the management activities provides the basis for developing ASSH's socio-biophysical model in future studies. The socio-biophysical model of ASSH will help researchers and policymakers to explore human impact on ASSH's functions (e.g. flood safety, recreational activities, and nature development).

Figure 1: Example of an anthropogenic sandy shore in the Netherlands: A) Sand Motor on the Dutch North Sea coast near The Hague, the Netherlands B) Beach houses and restaurant on Sand Motor and spread of beach users around them.

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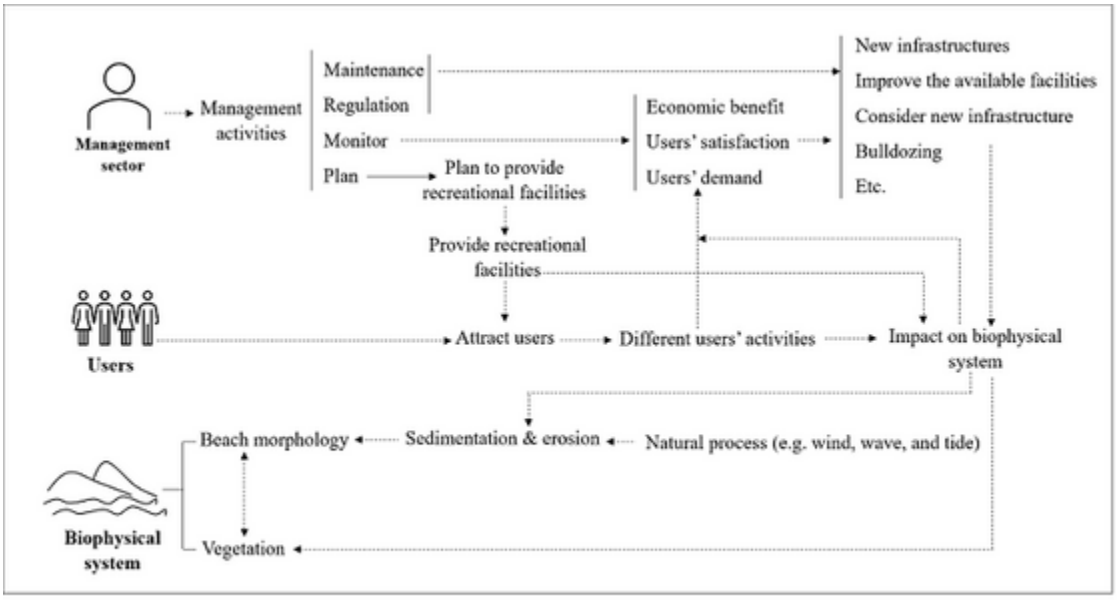

Figure 2: The primitive conceptual model of interaction between management activities, users and biophysical system

Keywords

Anthropogenic Sandy Shores, Coastal Management, Participatory Modelling, Fuzzy Cognitive Mapping

O10.4

The State of Chesapeake Bay and its Watershed in 2020.

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Abstract

Chesapeake Bay is the largest enclosed coastal sea in the United States. Located on the East Coast of North America, the Bay watershed covers 166,000 km^2 , including parts of 6 U.S. states and Washington, D.C. (the District of Columbia). The ecosystem of Chesapeake Bay is severely stressed by the impacts of population growth and development, resulting in a large "dead zone" where dissolved oxygen levels are too low to support healthy fish and shellfish populations. Since 1983, the States of Maryland, Virginia, Pennsylvania, the District of Columbia and the federal government have spent billions of dollars on a comprehensive, integrated Bay and watershed restoration effort to protect and restore living resources, vital habitats, and water quality, promote and achieve sound land use and good citizen stewardship. These efforts have encompassed forest and wetland protection and restoration, agricultural nutrient management and land management improvements, waste water treatment plant upgrades, urban/suburban stormwater management, air pollution emission reduction, citizen education and other measures that have resulted in reversal of decades of degradation and some improvement in the health of Chesapeake Bay, but that improvement has been slowed by continued population growth and development in the watershed. Sea level rise, increasing temperatures and changing rainfall distribution and increasing rainfall intensity in the watershed resulting from global climate change are adding to these challenges. Following an extensive 2-year reevaluation of their efforts in 2017, the Bay jurisdictions announced new targets and developed enhanced restoration plans in early 2019. These new plans are now being implemented to increase ongoing efforts in all sectors, agriculture, urban runoff, wastewater treatment, Bay and watershed habitat restoration and species management, and adapt those efforts to address climate change impacts. This presentation will document results of these unprecedented actions in one of world's longest-running integrated coastal watershed restoration and protection efforts.

Keywords

Chesapeake Bay, Coastal Watershed, Ecosystem Restoration, Pollution control

O10.5

Genesis and Effects of a Laterally Constrained River Mouth: ~100 yrs of human intervention in the Magdalena River Mouth (South America)

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Abstract

The Magdalena River (Northwestern South America) has one of the highest sediment yields among the major rivers of the world and provides nearly 38% of the total amount of suspended sediment discharged into the Caribbean Sea. The main distributary was intervened in 1936 after the construction of two extensive groynes. Since then, several additional engineering structures have been built along the river mouth. A series of maintaining activities, such as dredging, have been also carried out on a periodic basis. Comparison of ancient cartography, geo-referred aerial photography, satellite imagery, and bathymetric datasets from different periods, allowed to analyze the geomorphological/physical response of the system at different timescales. In addition, the net effect of such human interventions on the hydro-sedimentary regime and nutrient cycling was analyzed through the revision of data on streamflow, suspended sediment, and nutrient load. The influences of man-made structures were beyond the physical reshaping of the adjacent coast, which shifted completely, also included the progressive loss of fragile geomorphic systems as mangrove swamps, coastal lagoons, and barrier islands. The littoral became highly sensitive to morphodynamic factors, not just due to the depletion of sediment supply from the river mouth but also to the disappearance of such geomorphic features. They also disrupted the connection between mainstream and coastal lagoons, distributary channels, and intertidal plains, modifying the residence time within the estuary, and ultimately altering the net ecosystem productivity (NEP). Man-made structures also inhibited the planform morphological response to the changes in the sediment transport regime, leading to severe changes in the patterns and rates of sedimentation. The Magdalena River mouth provides an illustrative example to study physical/estuarine processes in a river mouth system where a low capacity of morphological response to environmental changes interacts with a high-magnitude sediment transport regime.

O10.6

Long-term Changes in Chesapeake Bay Water Quality: An Integrated Assessment of Dissolved Oxygen, Chlorophyll-a, and Water Clarity

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Abstract

To protect the health of aquatic living resources of Chesapeake Bay, the Chesapeake Bay Program partnership has developed a suite of recommended water quality (WQ) criteria subsequently, adopted into tidal states' WQ standards according to five designated uses (DUs). A multimetric attainment indicator approach was then developed to measure progress toward meeting the WQ standards. Over three decades of monitoring data of dissolved oxygen (DO), chlorophyll-a, and water clarity/underwater bay grasses were evaluated using the indicator approach for all 92 tidal management segments of the Bay. Results show that 40% of tidal water segment-DU-criterion combinations were estimated to meet their WQ criteria in the 2014-2016 assessment period, which marks the best 3-year status between the 1985-1987 and 2014-2016 assessment periods. Since the 1985-1987 period, the Baywide indicator has followed a nonlinear trajectory, consistent with impacts from extreme weather events and subsequent recoveries. Over the entire period (1985-2016), however, the Baywide indicator exhibited a positive and statistically significant trend ($p < 0.05$), indicating that the Bay's condition has been recovering since the 1980s. This improvement was statistically linked to the reduction of total nitrogen load from the watershed, suggesting responsiveness of the indicator to management actions. In further work, an analytical extension to the existing assessment framework was introduced to quantify the amount of impairment shown by the space-time exceedance of a specific criterion (referred to as "attainment deficit"), which can indicate how close a segment is to attainment if it is not currently attaining DO standards. This extended framework improved our understanding of the temporal patterns of DO attainment within each DU, salinity zone, and tidal system. Such insights are critical to the management and research community for understanding the dynamics of the Bay ecosystem and for further assessing the effectiveness of management initiatives aimed toward the Bay restoration.

Keywords

water quality standards, monitoring and assessment, ecosystem management, coastal restoration

O11.1

Nitrous oxide fluxes at the sediment-water interface of a hypersaline lake on the east coast of India

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Abstract

Nitrous oxide (N_2O), an important greenhouse gas (GHG), is produced in marine environments, including coastal waters and sediments. Benthic exchange of N_2O is one of the key processes occurring in coastal sediments. Pulicat lagoon is a hypersaline lake connected with the coastal waters of Bay of Bengal on the east coast of India. Fluxes of N_2O at the sediment-water interface of this shallow coastal ecosystem were investigated in December, 2020. Incubation experiments were carried out with sediment samples collected from three sampling locations of the lake. N_2O flux rates ranging between -4.57 µmol/m^2/d and -0.8 µmol/m^2/d were observed at the three stations sampled.

Nitrous oxide fluxes at the sediment-water interface are driven by both production and loss of N_2O in the sediment and the overlying water column. These production and loss processes are largely carried out by microbes. Nitrification (which produces N_2O as one of the intermediate compounds) in the water column was investigated indirectly through the use of nitrification inhibitor, allylthiourea (ATU). ATU is known to limit oxidation of ammonia (rate limiting step of nitrification) and subsequently, production of N_2O in the water column. Our results indicate that nitrification plays the key role in N_2O production in our study area. In this region, N_2O loss processes in the sediment were found to dominate over the production processes. Microbial reduction of N_2O to dinitrogen (N_2) is likely the major N_2O loss process in the sediment, leading to a net negative N_2O flux. Even in the absence of sediment, decrease in N_2O concentration was observed in water column of two locations. Further examination through the use of other growth promoters/inhibitors and molecular techniques would provide more insight into N-cycle processes.

Keywords

Nitrous oxide, hypersaline lagoon, benthic exhange, nitrification

O11.2

Assessing Marsh Ecosystem Response to Increased Temperature (MERIT) - A new ecosystem warming experiment in tidal wetlands

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Abstract

Salt marshes are a vital habitat for many plant, bird and invertebrate species, including soil fauna, and therefore, they play an important role in the protection of biodiversity. In addition, salt marshes are recognized for their high potential for ecosystems services such as coastal protection and carbon sequestration. Therefore, we need to understand how the valuable and sensitive salt marshes are affected by the on-going global change. The aim of this project is to better understand effects of warming on the interplay between plants, soils, and ecosystem functions in Wadden Sea salt marshes. To do so, a world-unique ecosystem warming experiment was installed at Hamburger Hallig including experimental passive aboveground and active belowground heating in three vegetation zones. In each zone nine plots are subjected to one of three warming treatments since summer 2018. The warming treatments include a +1.5°C and a +3.0°C experimental warming, as well as a control treatment with ambient temperature. We study how plants and soil fauna, as well as their interactions, are affected by natural abiotic conditions and by experimental warming. Furthermore, we investigate how this interplay in turn affects critical ecosystem functions and services, especially in relation to carbon sequestration, coastal protection and greenhouse gas emissions. Here, we present an overview of the experimental design with a focus on the active electrical belowground heating in this tidal environment. Overall, our results are expected to contribute to the development of sustainable management strategies for salt marshes in the Wadden Sea National Parks and elsewehere in times of climate change.

Keywords

salt marsh, rising temperature, climate change, blue carbon

O11.3

At breaking point – The impact of biophysical plant properties and seasonality on the resistance of tidal marsh vegetation to hydrodynamic forcing

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Abstract

Authors of the *IPCC Special Report on the impacts of global warming of 1.5°C (2018)* predict that storms and wave action and thus their potential impact on coastal wetlands, may be amplified in a warmer world. The coastal protection function provided by the vegetation of wetland ecosystems, like tidal marshes or mangrove forests, will therefore (a) play an important role in defending coastlines against storm surges in the future and (b) depend on how these systems respond to such forcing. If the physical stress of hydrodynamic forces becomes too high, the risk of vegetation failure and thereby its loss of functionality in coastal protection increases. Yet, this crucial knowledge on how hydrodynamics in turn affects tidal marsh plants is missing.

First results will be presented of a true-to-scale flume study, which was conducted to better understand and predict responses of tidal marsh vegetation to extreme hydrodynamic forces. Five tidal marsh plant species differing in their biophysical properties were exposed to varying wave conditions. Additionally, some species were artificially weakened as we expected seasonal changes in plant resistance, as the leaves and stems of examined species die off during the winter and their biophysical properties may undergo considerable modifications. In addition to non-destructive methods to detect plant disturbance, biogenic silica and lignin content as well as stem flexibility were quantified as they are known to affect the plant's resistance to hydrodynamic forces. Results indicate a higher plant resistance than expected, even under highest wave energy levels. This might be of significance for models that expect aboveground biomass to disappear during initial storm surge exposure and thus not continue to contribute to wave attenuation at later stages of the storm or successive storm events.

Keywords

Flume experiment, Plant disturbance, Nature-based coastal protection, Climate change

O11.4

The use of small-Unmanned Aerial Systems for high resolution analysis of tidal creek evolution

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Abstract

Tidal creek networks play an important role in coastal wetland environments. However, little is known of the early evolution and development of tidal creek networks and there is a lack of quantitative analysis of field datasets and measurements. One environment that allows for empirical studies of creek evolution is wetland restoration schemes, such as managed realignment (MR) sites, through the transition from a non-channelled to channelled landscape. However, previous studies assessing morphological development in MR sites have relied on surveying techniques, such as LiDAR, which lacks the surveying resolution and frequency required to identify subtle (but important) changes in morphology. Small-Unmanned Aerial Systems (sUAS) are being increasingly used across a number of scientific disciplines to provide high resolution imagery which, through the low-cost photogrammetric method Structure-from-Motion (SfM), can be used for high resolution topographic reconstruction.

This study assesses the suitability of this approach for measuring creek evolution in intertidal wetlands. Three sUAS surveys from were taken from a near-breach site at a large open coast MR site, the Medmerry Managed Realignment Site, UK (breached September 2013), to assess morphological evolution. Results indicate the surveyed area experienced up to 85 cm of accretion between 2016 and 2018. Stream order analysis classified the creek networks into five orders in 2016 (total: 291) and four orders in 2017 (total: 117) and 2018 (total: 112). This study provides an innovative high resolution insight into the evolution of restored intertidal wetlands, and suggests that SfM analysis of images taken using a sUAS is a useful tool in order to investigate creek morphogenesis. Findings are discussed in terms of the potential for sUAS analysis to advance the management of intertidal wetlands in order to ensure the provision of ecosystem services, and to protect against future anthropogenic activity, sea level rise and climate change.

Keywords

Tidal creeks, small-Unmanned Aerial Systems, Wetland Restoration, Intertidal Morphology

O11.5

Effect of patchy vegetation canopies on turbidity currents: Hydrodynamics and sediment deposition

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Abstract

Interactions between turbidity currents and aquatic vegetation canopies have landscape-scale consequences. It has been carried out a study focussed on comparing hydrodynamics and sediment deposition in continuous canopies with those in vegetation patches besides on the effects of varying water depth.

Twenty-five runs were carried out in a lock-exchange flume fully vegetated, and with shorter vegetation patches. Varying canopy frontal densities, a, and five water depths, H, were used. The currents' particulate load was characterised as a mix of fine and coarse fractions.

In all runs, the currents evolved through inertial (i.e. its frontal position, x_c, varies as t^1), drag-dominated (i.e. x_c varies as $t^{1/2}$) and viscous regimes (i.e. x_c varies as $t^{1/5}$). The transition position between the regimes in the fully-vegetated experiments varied linearly with aH for $aH < 0.8$, and were constant when $aH > 0.8$. Results suggest that variation at lower values of aH is caused by non-canopy drag forces becoming non-negligible compared to the canopy drag. It has been modelled, as a function of a and H, the size a vegetation patch needs to be for its effect on turbidity currents to be the same as that of a continuous canopy.

Sediment depositional flux rate for fine particles from the currents within the vegetation was found to be greater than that for coarse particles, by a factor of 1.57. This suggests that bed sediment deposited within canopy patches will be on average finer than that in gaps between patches, as has been found previously for currents and waves. Distances, over which the phenomena we document occur in typical inter-tidal and shallow sub-tidal contexts, are found to be of the same order of magnitude as sizes of patches of saltmarsh plants and seagrasses. Then the reported patch length effects are highly relevant to understanding eco-hydrological interactions in these contexts.

Keywords

Turbidity current , Vegetation canopy , Patch length, Sedimentation

O11.6

Mean residence time of lagoons interspersed in wetlands

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Abstract

Lagoons interspersed within natural or constructed wetlands are expected to increase the residence time of the flow in the ecosystem, leading to an increase in the pollutant removal and ensuring a good ecological status of the ecosystem. In this study, lagoons interspersed in vegetated wetlands have been mimicked in a laboratory flume in order to establish the impact three major driving parameters (the vegetation density surrounding a lagoon, the depth aspect ratio (length versus depth) of the lagoon and the circulating flow) have on the residence time of the flow in the lagoon. The experiments were carried out with natural vegetation, *Juncus maritimus*. The results indicate that the presence of vegetation decreases the residence time though the short-circuiting of the flow, due to the presence of preferential flow paths generated in the vegetated shallow zones. The vegetation also enhances the mixing of the flow at the leading edge of the lagoon. Vertical downward velocities at the leading edge of the lagoon and positive velocities at the trailing edge of the lagoon were observed. The vertical velocity gradient at the center of the lagoon was greater as the lagoon length decreased, due to both the greater proximity of this point to the vegetated shallow zones in small lagoons. An increase in the mean flow velocity or a decrease in the lagoon depth resulted in a decrease in the lagoon residence time, reducing the potential of lagoons in treating pollutants. The length of the lagoon, however, was found not to affect the residence time. High lagoon residence times in either natural or constructed wetlands are desirable because they enhance pollutant removal from the water. Although, if the residence times are too long, this may lead to anoxic water conditions that could in fact threaten the wetland's ecosystem.

Keywords

lagoons, wetlands, residence time, unidirectional flow

O11.7

Impact of changing the management of an urban wetland on its biodiversity and its ecological functions through the study of planktonic communities: the case of the Tasdon wetland (Charente-Maritime)

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Abstract

Wetlands are typically ecosystems sheltering a high biodiversity. They provide many ecosystem services such as water purification, can act as buffer zones against flooding, and recreational area for people. Proper management of wetlands is therefore crucial in order to preserve their assets. The objective of this study is to determine the impact of the renaturation of a coastal urban wetland (Tasdon, Atlantic coast of France) including watercourses rectification, landscapes remodelling and reconnection to coastal waters, on biodiversity and ecological functioning by studying planktonic communities. A first series of seasonal sampling of abiotic factors (nutrient concentrations, temperature, salinity, pH, etc), and biotic factors (bacterial, phytoplanktonic and zooplanktonic communities) was carried out in 2019, prior to the redevelopment of the wetland, at 3 stations at different seasons. The redevelopment of the wetland was analysed to determine the planktonic diversity and their biomass, and to characterize the succession of food webs for each station and the associated ecological functions. Initial results showed that in 2019, the Tasdon wetland displayed a high plankton diversity (66 metazooplankton species) including 3 tropical species. The highest diversity within the stations was observed in summer. Four types of food webs have been identified, and their succession is largely dependent on a seasonal effect. Comparison with the results of a second sampling campaign, carried out in March 2021, will allow to assess the impact of water management change on plankton diversity, food webs structure and functioning. This comparison should provide with crucial knowledge to adapt wetland water management to optimize the ecological functions that support a rich biodiversity and its assets.

Keywords

food web, renaturation, biodiversity, ecosystem services

O11.8

Biogeochemical carbon-sulfur-metal-water cycling after flooding of a coastal wetland and its underlying aquifer

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Abstract

Land-ocean interactions in the coastal zone are of particular interest regarding the exchange of substances, like nutrients, carbon, sulfur, metals, and water. We present new results on the biogeochemistry of coastal sediments and an adjacent recently rewetted wetland in the southern Baltic Sea, that are under impact of dynamic water exchange. Sequential pore water samplers were applied to follow the dynamics of the seasonal pore water composition in the coastal sediments. Sediment cores on transects within the Huetelmoor were investigated for the pore water and soil composition. The fractions in the soils were analyzed for the elemental composition, mineral micro-textures, and the hydrogen, oxygen, carbon and sulfur isotope composition of different fractions to understand the water and biogeochemical carbon-sulfur cycles.

Flooding events with brackish water add sulfur to the peatland and the isotope signals and metal contents of peatland surface waters indicate an impact exchange with underlying anoxic solutions. Water isotopes indicate seasonal evapotranspiration and mixing processes. A recent massive storm-induced flooding event led to the salinization of the surface peatland as well as the underlying aquifer.

The peat cores were found to reflect the activity of sulfate-reducing bacteria and the associated formation of pyrite with different textures, as well as isotope evidence for sulfurization of organic matter. Sedimentary sulfur fractions and their stable isotope signatures are controlled by the availability of dissolved organic matter or methane, reactive iron, and in particular dissolved sulfate and, thereby, from the relative position to the coast line and the given lithology. The sulfur isotope compositions of the iron sulfide fraction are controlled by the availability of sulfate and vary in agreement with spatial and temporal dynamics in the impact by salt-bearing solutions. Further mechanistic investigations consider the role of DOS upon changing sulfur substrate availability.

Acknowledgement for support by BALTIC TRANSCOAST, DAAD, ERASMUS

Keywords

Wetland, Submarine Ground water discharge, Flooding, Isotope Biogeochemistry

O12.1

The effects of hydrological extremes on nitrogen loss through denitrification and recycling via DNRA and mineralization in a coastal lagoon

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Abstract

Hydrological extremes, which are periods characterized by unusually high or low discharge, may have profound effects on nitrogen transport and on sediment biogeochemistry in transitional zones, but such effects are poorly explored. In this study, microbial nitrogen transformations were analyzed by means of intact core incubations and the ^{15}N-isotope addition at three sites (one freshwater and two marine ones) in a eutrophic lagoon both under high discharge (spring) and after prolonged low discharge (late summer) of the main freshwater inputs.

Results suggest a pronounced shift among dominant microbial N transformations with denitrification as leading process and little to no recycling during high discharge and high nitrate period, and high recycling during low discharge period. During spring the freshwater site exhibited the highest rates of N_2 production (up to 1150 ± 81 µmol N m^{-2} h^{-1}), mostly sustained by nitrification stimulated by burrowing macrofauna activity. During late summer denitrification dropped at all sites due to low discharge coupled with low nitrate concentration and to reduced bioturbation and nitrification. The highest recycling was measured at the marine sites and particularly at the clams cultivated area (up to 1003 ± 70 µmol NH_4^+ m^{-2} h^{-1}), and it was sustained by ammonification of biodeposits and excretion by bivalves. Concurrently, dissimilatory nitrate reduction to ammonium (DNRA) became an important path of N recycling, representing on average 30% of nitrate reduction processes.

Flash floods and high nitrate may offset denitrification due to reduced residence time and saturation of microbial activity, resulting in high transport of nitrate to the open sea. Prolonged dry periods favor large N regeneration by sediments, due to combination of high temperatures, low oxygen solubility and low bioturbation, which may prolong the extent of algal blooms, with negative feedbacks for the lagoon biogeochemical services.

Keywords

nitrogen, sedimentary fluxes, estuaries, climate change

O12.2

Urban estuaries provide global opportunities for restoration

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Abstract

Growing populations and industrialisation threatens the important ecosystem services (flood protection, maintenance of water quality, fisheries & tourism) provided by urban estuaries. Our study presents a socio-ecological systems framework for the restoration of urban estuaries. This integrates our understanding of the connectivity between land, water and people and responses to climate change. Restoration and estuary management takes place in an adaptive management cycle where objectives are set, actions implemented and then monitored. Outcomes are analysed and objectives adapted if necessary in a learning by doing approach. Climate change effects must be included in plans and policies dealing with the management, restoration and governance of estuaries. Multiple stressors from pollution and climate change represent a double whammy for urban estuaries. Alterations in rainfall patterns, sea level rise and extreme events like storm surges will change chemical behaviour associated with changes in temperature, pH and oxygen and the remobilisation and flushing of contaminants. Research has shown that urban estuaries are under severe pollution pressure and that improvement of water quality as a key intervention would lead to significant improvement in estuary health and associated benefits that society derive from them. Innovative methods for water quality improvement such as Sustainable Urban Drainage, artificial wetlands and biomimicry are discussed. This research is globally relevant as it addresses the objectives of the UN Decade of Ecosystem Restoration (2021-2030); "by restoring, conserving, and wisely using our wetlands we can contribute towards achieving the Sustainable Development Goals". Restoration interventions contribute towards sustainable cities and communities by generating employment opportunities and reducing vulnerability to climate related events and economic shocks.

Keywords

water quality, socio-ecological, stressors, climate change

O12.3

The interaction of aquaculture and agriculture effluents with extreme weather events boosts coastal eutrophication and habitat loss

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Abstract

In the Anthropocene the combined effects of global climate change and human uses are most severe in the coastal zone, where population density is disproportionately high and increasing. There, the effects of coastal development and hinterland influence as well as rising sea levels and an increasing frequency of extreme weather phenomena endanger the integrity and ecosystem service supply of estuaries and coastal ecosystems.

The Chinese island Hainan is an extreme example in this context. Its coasts were once lined with mangrove forests, seagrass meadows and coral reefs, the beauty of which founds their economic potential for tourism, a major and growing business sector. However, activities in other major economic sectors, i.e. agriculture, aquaculture and urbanization/industrialization, as well as an average eight typhoons per year impair the functioning of coastal ecosystems.

Starting in the 1960s mangroves were massively deforested and converted into aquaculture ponds, which became a major pillar of Hainan's economy. Untreated wastewater including large amounts of anthropogenic nutrients and organic matter is released into semi-enclosed coastal bays or directly into coastal back-reef areas, where it leads to eutrophication, seagrass loss and coral reef degradation.

During the typhoon season the effluents from agriculture and aquaculture, which usually have a localized impact within the semi-enclosed estuarine Bamen Bay only, can be exported into coastal back-reef areas in pulses as a result of typhoon-induced heavy rainfall. There, they contribute to coastal eutrophication in areas which are otherwise less exposed to aquaculture effluents.

This example illustrates how extreme weather events, which are projected to increase, can exacerbate the negative effects of anthropogenic nutrient pollution, in particular along heavily used tropical coasts.

As a consequence of our inter- and transdisciplinary collaborative Sino-German projects LANCET, ECOLOC and TICAS we established a dialogue with stakeholders and we propose measures to preserve the valuable coastal ecosystems.

Keywords

Eutrophication, Land use change, Seagrass loss, Typhoon

O12.4

Assessing water quality change under future climate condition in Chesapeake Bay by using numerical model simulation.

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Abstract

Climate change has the potential to impact water quality in the coastal oceans, and robust future projections are critical for adaptation and restoration planning. A series of climate change scenarios have been simulated to examine the influence of future climate conditions on water quality by 2055. Three major changes under future climate condition were taken into account: sea level rise, air temperature warming and nutrient loading increase. There are two types of sea surface level projection available in the Chesapeake Bay region: the probabilistic method and the quadratic function method. The results of the two methods are quite comparable in the region and the averaged sea level rise was used: 53 cm by 2055 as compared to 1995. Down-scaled analysis of 31 global climate models (GCM) projected that air temperature will increase by 1.96 ℃. The CBP partnership's newly developed Phase 6 Watershed Model was used to project nutrient loading increase: by7% for nitrogen and 15.9% for phosphorus. The estuarine model showed that air temperature has the most impact on water quality due to decreased DO solubility and increased biogeochemical processes and stratification. However, a significant portion of the adverse influence of climate warming on water quality is balanced by sea level rise, which improves water quality due to increased gravitational estuarine circulation and renewal of bottom water where hypoxia occurs. Results, analyses, and management implications will be presented in detail at the conference.

Keywords

Climate Change, Chesapeake Bay, Water quality, Modeling

O12.5

Comparative Study NbS and Tourism Management in Coastal Sand Dune Conservation Areas

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Abstract

Coastal ecosystems are degrading worldwide due to human activities and climate change. However, at many places along the shoreline, sand dune systems are still a vital part of the coastal defense. The awareness on the importance of sand dune conservation is growing, and actions are taken to maintain landscape features and increase resilience through Nature-based Solutions (NbS). Often by establishing a coastal geopark or a national park, sand dune areas can be conserved or enhanced. But, in the context of NbS, different benefits should come forward and therefore the conservation areas also focus on attracting tourists, stimulate local economies and provide environmental education or leisure activities for visitors. In many cases, governments are now focusing too much on the economic benefits of tourism and forget about the negative side-effects. The relationship between tourism and the natural environment is important for the future of the sand dune areas. More data is needed on this relationship, especially in this time of global pandemic when more people go out in nature, it becomes increasingly challenging to find a balance between tourism and nature conservation. For this study five categories of main tourism impacts on dune vulnerability were defined after a literature research; trampling, illegal structures, unmanaged roads and paths, waste, and leisure activities in the dunes. The management strategies to reduce these impacts are assessed. Based on the results of this study, evaluation of the implemented strategies is vital to determine their effectiveness, but is still lacking in many cases or is focused on just one factor. It will be valuable to also determine evaluation strategies for existing and emerging coastal (geo)parks in sand dune areas. Furthermore, an all-inclusive assessment is required for each specific dune area, including as many stakeholders as possible, to develop a sustainable tourism strategy.

Keywords

Coastal Sand Dunes, Tourism, Nature-based Solutions, Management Strategies

O12.6

Human efforts vs “Human nature” – the EU Life Re.S.C.WE study case

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Abstract

Climate change and human infrastructures heavily affect seashore dynamics with cascading consequences on coastal sand dunes which are transitional ecosystems hosting threatened habitat and various ecosystem services. Therefore, dune restoration has been recurrently applied as a tool to minimize coastal risks and ensure the biodiversity conservation. In this work we investigate the EU Life Re.S.C.We. (Restoration of Sentina Nature Reserve Coastal Wetland (2010-2013) and relative after-Life activity (2013-2020) results, with respect to climate change and coastal erosion.

To do this, we analysed the spatio-temporal distribution of i) dunes system, ii) threatened plant species’ individuals implanted during the after Life, iii) coast line, and the evolution of climate conditions that characterized this area.

The erosion is particularly strong here and moreover in the last ten years many very intense or exceptional marine storm events were observed (11/13/2020, 12/7/2019, 12/2/2013). Based on that dynamic we observed i) a loss of about 68% of the threatened plant species’ individuals implanted, ii) the disappearance of dunes protection systems, iii) a retreat of the coastline of 22 meters during the after Life. Finally, considering the coast retreat speed we estimate that the sea could reach the natural and reconstructed retrodunal lakes within about 4 and 17 years, respectively.

The permanence of the implanted species is here strictly related to the degree of the coastal erosion, as well as the dunes stability. The strong climatic extremization in progress in the Mediterranean basin involves a more frequent formation of Mediterranean depressions, heralds of strong winds and storm events of intense magnitude that could become no longer exceptional but common. In order to ensure the long-term conservation of coastal habitats and their biodiversity, more intense efforts must be considered in particular regarding the mitigation of extreme marine storm events and related floodings.

Keywords

dunes system, EU Life activity, climate change, coastal erosion

O12.7

Dune habitat degradation by gulls at Barreta Island, South Portugal

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Abstract

Storm-induced erosion, sea-level rise, and human pressure are main threats to the perpetuation of barrier islands worldwide. However, the conservation of key habitat within these systems can also be threatened by internal positive feedbacks (revolt) inducing system regime shifts. To identify, assess and monitor dune vegetation perturbation observed in the grey dunes (priority habitat 2130) of Barreta island (Ria Formosa, South Portugal), we computed an index using different remote-sensed imagery from 2008 to 2020. Available imagery datasets consisted in orthophotos, Google Earth imagery, and drone surveys whose surfaces were classified into three classes (shrubs, herbaceous vegetation, and sand, corresponding to classes 1, 2 and 3, respectively) on a GIS environment and using an unsupervised classification method. The classified maps over time allowed the definition of areas where the vegetation cover appeared perturbated as those in which the sand cover (class 3) increased above 35% (typical sand coverage observed in areas recognized as healthy or non-perturbated grey dunes). Identified perturbated areas were compared with the distribution of two gull breeding colonies and censuses as well as human infrastructures and activities present in the island. Results showed that (1) there were two main perturbated areas within the grey dunes of Barreta Island exhibiting an increase in sand cover over time, (2) the main cause of perturbation was related to the presence of the gull colonies, and (3) the extension and degree of perturbation seemed to increase parallel to an increase in the number of gull breeding pairs of both gull colonies. The applied approach helped to characterise the conservation status of the grey dunes, which appear to have experimented a regime shift, or bifurcation event, induced by the positive feedbacks stablished between gulls and vegetation, proving to be very useful for informing future managing purposes.

Keywords

barrier island, dune perturbation, vegetation cover, conservation

O12.8

Manmade Restoration and Natural Evolution on the Northwest Coastline of the Mediterranean

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Abstract

Mediterranean Golden Northwest coastline spread on the east side of Iberian Pen, where is the holiday destination for northern EU residents heading south. In the middle of the 19th century, Europe entered a high-speed process of urbanization, real estate developers had built large areas of resorts, homes and playgrounds on the coastline, which has caused devastating damage to ecosystem of the coastline. Along with extreme changes in the climate, strong winds and sandstorms have continued to destroy fragile ecological areas (the Brave Coast, the Valencia Gulf) of the Northwestern Mediterranean coastline. In the early 20th century, the local district government decided to try to dismantle on the brave coast and the coast of Valencia. Can the role of manmade restoration intervention and natural evolution really contribute to the restoration of coastal ecosystems? We will apply remote sensing and other related technology to compare and analyze the evolution of the fragile landscape corridor ecological pattern on these two coasts over the past 20 years, exploring its regularity, and provide scientific basis for the restoration of the western coastline of the Pacific Ocean in the future.

Keywords

Northwestern Coastline of the Mediterranean, Fragile Landscape Corridor, Manmade Restoration, Natural Evolution

O13.1

Value of relationship in the Japanese satoumi

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Abstract

Satoumi is defined as “The coastal se with high biodiversity and productivity under the suitable human interaction” (Yanagi, 2006). Hinase in the central part of the Seto Inland Sea, Japan is famous for its successful restoration of eelgrass beds and Satoumi creation (Yanagi, 2013) .

The establishment of horizontal and vertical human relationship is tried in Hinase now. The establishment of horizontal human relationship is to cope with the people in Maniwa (the central part of Chugoku Mountain Area), that is, the fishermen in Hianase attend the Satoyama creation activities in Maniwa and the people in Maniwa attend the Satoumi creation activities in Hinase.

The establishment of vertical human relationship is the environmental education to the junior high school students in Hinase, that is, the students attend the restoration activities of eelgrass beds by fishermen, understand the present situation of their mother coastal sea and study the life of local fishermen.

Such establishment of horizontal and vertical human relationship may result in the development of future Satoumi, because the people in Hinase and Maniwa will get the merit by understanding the both situations and the students and fishermen also get the merit by understanding the both situations.

The establishment of human relationship has the value which will give the benefit to both.

Yanagi,T. (2006) Sato-Umi; a New Concept for Coastal Sea Management. TERRAPUB, Tokyo.

Yanagi,T. (2013) Japanese Commons in the Coastal Seas: How the Satoumi Concept Harmonizes Human Activity in Coastal seas with High Productivity and Diversity. Spinger, Tokyo.

Keywords

ICM, Satoumi, Relational value, Environmental Education

O13.2

Sato Umi in Thailand

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Abstract

We present two stories of Sato Umi in Thailand – bamboo fences for coastal protection and crab bank to enhance blue swimming crab population. Coastal erosion has long been a severe problem in Thailand for many years. A major cause is the transformation of mangrove area for aquaculture activities. Mangrove buffer as a coastal protector is lost and replaced by shrimp ponds. Coastal erosion is then stimulated when the pond ridge facing the shoreline is collapsed from wave action. There is a successful story of coastal protection by using bamboo fences initiated by local community. Bamboo poles are pinned as fences of about 10-trees thick parallel to the coast. Their elasticity can reduce wave energy with small wave reflection, unlike hard structure. Mangrove trees are planted behind the fences when sediment accumulation increases to stabilize the coastal sea floor. This implementation is very successful and has been introducing for other eroded areas around the country.

A market value of more than 3,000 million baht per year reflects the popularity of blue swimming crab consumption in Thailand making crab population drop to unsustainable level. Catching crabs having external eggs or “berries” results in huge population reduction. There is an effort by coastal fishing communities in many areas around the country to establish and carry out activities “Blue swimming crab bank” to restore the crab population. The key concept is letting mother crabs with external eggs having chance to hatch their eggs and release crab larvae before consuming or selling them. The mother crabs are husbanded either in floating cages in the sea or containers in hatcheries. The external eggs may be extracted and incubated in the hatcheries before releasing. This application has been proven to help increase crab population for sustainable use.

Keywords

community-based management, coastal protection, crab population restoring

O13.3

Possibilities of Satoumi which promote both EcoDRR and ICM

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Abstract

Introduction: Historically, traditional coastal EcoDRR (Ecosystem-based Disaster Risk Reduction) in Japan such as Fish Breeding Forest along the coast has long played an important role both on marine ecosystem sustainability and disaster prevention. However, disaster risk reduction has not been a major target of Satoumi concept during the first stage of Satoumi activities. Purpose of this paper is to make clear the possibilities of future Satoumi which can promote both EcoDRR and ICM.

Method: Historical change of coastal area of Japan was analyzed from the viewpoint of coastal ecosystem and disaster risk prevention. Satoumi activities so far done are also categorized with special reference to environmental restoration, disaster risk reduction and ICM. Some successful cases of Satoumi activities were examined from the standpoint of both EcoDRR and ICM.

Results: Artificial infrastructure for disaster prevention and transportation such as seawalls, banks and ports have been highly developed along the coast after World War II, especially during the nation's extremely high economic growth age. Such artificial structure had seriously damaged natural seashore including habitat such as seaweed bed and tidal flat. Although Satoumi activities positively restored deteriorated seaweed bed and tidal flat, Satoumi had not paid much attention to EcoDRR so far.

Discussion: Since it is exemplified that well developed mangrove forest, coral reef and seaweed bed can reduce coastal disaster risk, Satoumi activities which restore these ecosystem have potential possibility of EcoDRR. Satoumi in future should promote both EcoDRR and ICM as well as variety of activities so far done because coastal disaster risk is increasing with increasing population and human activities along the coast.

Keywords

Satoumi, EcoDRR, ICM, Restoration

O13.4

Connecting with stakeholders in Satoumi management: a case study on framing of rules for octopus fishing in Akashi City, Japan

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Abstract

Introduction

Local commercial and recreational fishers have been responsible for the organization of Satoumi, a strategy that focuses on integrated and comprehensive management of the land and coastal area. However, given the public nature of the coastal zone, diverse stakeholders should be involved. In this study, we examine how stakeholders in Akashi City, Hyogo Prefecture, Japan, were involved in octopus fishery rule-making.

Method

We conducted interview surveys of the main players involved in rule-making, extracted the factors involved in the situation, and created a list of stakeholders. Next, we analyzed the causal relationships between those factors and created a causal loop diagram of the factors. We also examined how various stakeholders were involved.

Result

The need for octopus fishing rules in this area arose from concerns of overfishing and the collision of ships at sea, resulting from an abundance of octopus fishers in the area. We created a causal loop diagram of the factors with three loops: overfishing octopus resources, boat collisions, and interest in resource management. The stakeholders were divided into four groups, where those most involved were the commercial and recreational fishers, followed by organizations of which they were members, organizations related to previous organizations and the general public, and finally the general public.

Discussion

The three loops involved in the octopus fishing problem were connected via the Coast Guard and the general public. In order to address the problem, it is important to have the institution communicate with

the two most involved groups of stakeholders, including the Coast Guard, to create a mechanism for relaying information between all stakeholder groups.

Keywords

Satoumi, Coastal Managemet, consensus building, rule-making

O13.5

Salmon-Safe: Human and Salmon Relationships, from Mountains to Oceans

Kevin Scribner

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Abstract

Salmon-Safe Certification has a guiding vision entitled *Mountains-to-Oceans*. This vision acknowledges the entire life-cycle of salmon. Salmon are born in freshwater mountain streams. When young they travel down connecting rivers to spend their adult lives maturing in the ocean. When mature, they return to the streams of their birth, to reproduce the next generation. The salmon life-cycle goes on, generation after generation, as it has for millennia.

Salmon-Safe believes salmon and people can live and thrive together. Salmon-Safe has developed a strategy that encourages both farmers and city managers to voluntarily agree to manage their lands to meet Salmon-Safe's science-based performance Standards.

Focused on water quality, Salmon-Salmon Standards require land management practices that eliminate or significantly limit the run-off of water from the land. If there is run-off, Salmon-Safe Standards insures it does not contain chemicals that are toxic to fish and other aquatic species. Salmon-Safe relies upon independent assessments to verify these Standards are being met. When Standards are met, clients can tell the world they are *Salmon-Safe.*

Salmon-Safe works to generate a *Salmon-Safe Culture*, where salmon safe practices are embedded into daily lives and then taught to successive generations. When a cultural tradition, entire communities will learn how to be salmon-safe. To achieve this, Salmon-Safe looks to *Satoumi*, "Village Ocean," as a model, as well as *Satokawa,* ("Village River")and *Satoyama,* ("Village Mountain"). Salmon-Safe's *Mountains-to-Oceans Vision* encourages it to learn from all three traditions: *Satoumi*, *Satokawa*, *Satoyama*.

*Salmon Nation*speaks to the relationships between people and nature found in *Satoumi*, but *Salmon Nation*expands this relationship to much of the Northern Pacific Ocean and its coastlines. United States salmon have been located off the coast of Japan. This geographic reach offers a relationship challenge for residents of *Salmon Nation*.

Keywords

salmon, rivers, ocean, culture

O13.6

ICM scale-up: Exploring a public-private partnership framework for the revitalization of Tokyo Bay, Japan

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Abstract

ICM is an effective method for achieving complex and comprehensive goals including satoumi, and is also described in the Basic Act on Ocean Policy as a management method for coastal areas in Japan. Many local governments have set the goal of "satoumi" and are promoting efforts. On the other hand, it is not easy to establish an effective ICM framework / system in large-scale enclosed bay. Tokyo Bay, which nurtured a rich Edomae culture, experienced environmental hazards such as landfill and eutrophication during the high-growth period (1960s), and has since endeavored to regenerate the environment through the implementation of the Water Pollution Control Law and Total Pollutant Load Control System (TPLCS).

Under such circumstances, National Bay Renaissance Project has been started in 2002, and a cross-governmental Tokyo Bay Renaissance Conference has been established since 2003. The conference enacted the action plan for the restoration of the Bay. In the first phase (2003-2012), strengthening of land area measures, sea area measures and monitoring system was made with the main purpose of achieving water quality and environmental targets. In the second phase (2013-2022), the Tokyo Bay Restoration Public-Private Partnership Forum was established, and voluntary commitments of multi-sectoral stakeholders' participation has been strengthened.

In the future, we believe that it is necessary to establish a comprehensive ICM system by implementing the COAST Card project toward the third phase of the action plan for the restoration of Tokyo Bay. Conducting the Social Network Analysis (SNA) for enhancing network of stakeholders, using the System Dynamics Modelling (SDM) for building a system for adaptive management of planning and implementing various rehabilitation actions corresponding to the global agenda in collaboration, and using the Report Card system for establishing inclusive mechanism to create a comprehensive urban style satoumi with public and private sectors.

Keywords

InteIntegrated Coastal Managementgrated Coastal Management, Public Private Partnership, Comprehensive Assessment, COAST Card

O13.7

Toward resilient and sustainable socio-ecological system establishment for Ishigaki Island and Sekisei Lagoon, Japan, with a comprehensive stakeholders partnership

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Abstract

Sekisei Lagoon is the largest coral reef in Japan, a part of Iriomote-Ishigaki National Park, having rich ecosystems with more than 360 coral species, and it is expected as a source area providing coral larvae over the Ryukyu Islands along with the Kuroshio Current. Therefore, it is very important to properly conserve the ecosystems in Sekisei Lagoon and its surrounding reef areas. Unfortunately, however, they have declined due to various threats like coral bleaching, soil runoff, and outbreak of crown-of-thorns starfishes (COTS). The periodical monitoring data indicated that massive coral bleaching both in 1998 and 2007 caused sharp decline in the coral covers. The average values of coral coverage showed a good recovery after 1998, while that after 2007 showed almost no recovery. This means the reef ecosystem has lost its resilience after 2007. The monitoring data indicated the recruitment rate of corals has significantly decreased and COTS outbreak become prominent after 2007. Numerical modeling studies in a perspective of an island-coastal-ocean linkage system and data analyses have revealed that soil and nutrient runoff from the adjacent Ishigaki Island may be possible causes of the loss of the ecosystem resilience. Although many efforts have been made by various stakeholders, the status of the ecosystems is still poor and the resilience has not yet well recovered despite the increasing concern of climate change impacts in near future. The basic questions are “how to realize a resilient socio-ecological system under the combined local and global threats?” and “how to realize a “sustainable island” system as a whole?” For effectively achieving these goals, we need to establish a new framework in which various local stakeholder individuals, groups, and institutions, including the youth, may actively collaborate with each other as the main players. Our COAST Card Project should contribute a lot for all these.

Keywords

Coral reef ecosystem, resilience, socio-ecological system, COAST Card

O13.8

Manila Bay : a challenge to coastal transformation and sustainable development

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Abstract

Manila Bay is strategically located in the Philippines and has a long history of use for shipping, navigation, and port services. With its natural features (topography, bathymetry, circulation) and multiple functions from stakeholders' conflicting needs, the Bay can be considered a complex ecosystem. The major environmental problems include deteriorating water quality, declining fisheries, coastal subsidence, and saltwater intrusion. The expansion of aquaculture, human settlements, commercial establishments after land conversion of mangroves and tidal flats, and other reclamation projects have prevailed in recent decades. To address the continued pollution in the Bay, the Supreme Court issued a writ of "continuing mandamus" in 2008, compelling 13 government agencies headed by the Department of Environment and Natural Resources to "clean up, rehabilitate, and preserve Manila Bay" and bring back its waters to a state fit for swimming, skin diving, and other forms of contact recreation. The Manila Bay Coordinating Office has been facilitating environmental management and coastal rehabilitation efforts with help from stakeholders and the general public. A Manila Bay Development and Sustainability Plan (MBDSP), completed in July 2020 and to be implemented up to 2040, focused on inclusive growth, ecosystem protection, Disaster Risk Reduction and Climate Change Action, water quality improvement, and housing for informal settlers. However, with pressures from influential sectors, meeting the goals of the MBDSP will be a big challenge.

Manila Bay is one of the study areas of the Belmont Forum COAST Card project, which is a transformative, transdisciplinary, and transnational approach to coastal and marine research and management. The project aims to add value to present initiatives in the Bay by using various tools and measures, i.e., Stakeholders Network Analysis (SNA) and Systems Dynamics Modeling. These consider both social and physical factors as inputs to the COAST Card, a participative and holistic tool for coastal ecosystem management.

Keywords

Manila Bay, COAST Card, Stakeholders Networks Analysis, Systems Dynamics Analysis

O14.1

Optical remote sensing of mass concentration for POC based on specific absorption by phytoplankton for optically complex Case 2 waters

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Abstract

Remote sensing of mass concentration for Particulate Organic Carbon (POC) in Case 2 waters poses a greater challenge owing to spectral interferences from biogeochemical components and marginally low values of Colored Dissolved Organic Matter (CDOM) in global oceans. POC concentration plays a critical role in marine carbon cycle, determination of penetration depth for UV -B rays, estimation of primary productivity and have major implications in investigating the seasonal trend about the distribution of phytoplankton biomass for a given geometric illumination condition. The present model has been developed based on an inverse optical modelling technique for determining the mass concentration for POC wherein, the ratio of specific absorption by phytoplankton (denoted by a^*_{ph}) at blue to green ratio was used as input parameter and subsequently, match-ups for the satellite derived product was obtained using MODIS dataset. An inverse power function was developed to estimate *in-situ* mass concentration of POC following a best-regression fit for dataset covering wide range of optically complex water types (coastal and turbid productive waters). The inclusion of chlorophyll-based specific absorption coefficient, a^*_{ph} with blue-green ratio accounts for the variation in-packaging effect and community structure of chlorophyll which governs the variability in POC concentration. The bio-optical algorithm for POC concentration was developed and fine-tuned using NOMAD dataset, extracted from SEABASS. The modelled POC concentrations showed a good agreement with *in-situ* POC values with significantly low error of and correlation coefficient of nearly 0.9. Spatial structures generated for the coastal and deep waters of Arabian Sea for MODIS imagery (1 km X 1 km resolution) revealed significant increase in the levels of POC during the summer seasons due to high abundance of diatoms species and higher for waters of Arabian sea. Satellite derived POC values was also found in agreement with *in-situ* POC concentration with MRE of ±35%.

Keywords

Particulate Organic Carbon, , Remote Sensing Reflectance, Primary productivity, Chlorophyll concentration

O14.2

Community diversity and geomicrobial role of sulphate reducing bacteria in two tropical coastal lake sediments

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Abstract

Sulphate reduction is a key biogeochemical process driven by sulphate reducing bacteria (SRB) composed of diverse taxa of anaerobic microorganisms that use oxidized sulphur compounds as terminal electron acceptors. However, the structural and functional diversity of SRB in tropical coastal environments are largely unknown. Hence this study aims to explore the taxonomic diversity of SRB for the first time and compare the diversity and sulphate reduction activity of two coastal lakes, Ashtamudi and Vembanad, which are designated as Ramsar sites.

Microbial biogeochemistry studies of the two lakes revealed that the lakes are contrasting in terms of their predominant biogeochemical functions, with sulphate reduction in Ashtamudi and methanogenesis in Vembanad lake. To verify the diversity and dominant taxa of SRB, microbiome profiling of SRB was done by New Generation Sequencing (NGS) methods (Illumina sequencing) based on gene amplification of dissimilatory sulphate reductase (dsr) enzyme.

Sulphate reduction potential of Ashtamudi was nearly two fold than that of Vembanad lake. In Ashtamudi, SRB was represented by a diverse population than Vembanad and the marine zone of Vembanad harboured more diversity than freshwater zone. SRB in Ashtamudi was represented by more diverse and less abundant taxa. This is evident from the alpha diversity index, which was high in Ashtamudi (6.55) with 3295 observed species, compared to the freshwater zone (1.825) and marine zone of Vembanad (4.069). The differential diversity of SRB has implications not only on sulphate reduction, but also on methane production during organic matter degradation. As SRB are versatile in their metabolism, their role in biodegradation of pollutants in the sediments are also explored. *Desulfovibrio*, which has a pivotal role in degradation of contaminants was found to be the predominant genus in both lakes; however, the variation in its species between lakes is probably a result of selective predominance rather than endemism.

Keywords

sulphate reduction, structural diversity, functional diversity, organic matter degradation

O14.3

Sediment bioturbation does not influence anaerobic biogeochemical activities in a tropical coastal wetland

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Abstract

Estuarine sediments harbour a plethora of life forms that engineer the structural and functional properties of these sediments. A large consortia of microorganisms, especially bacteria and archaea take part in organic matter breakdown as part of their respiratory mechanisms and along with macro- and meiofauna which work through bioturbation, independently or synergistically maneuver the process of diagenesis. Apart from sediment biogeochemical factors, several physical factors like sediment reworking by benthic fauna, sediment grain size and depth are driving forces that influence the structure and functions of microbial communities. In this study, the primary objective was to discern whether the two parallel activities of anaerobic bacteria (sulphate reducers) and archaea (methanogens) intersect with sediment bioturbation, and thus influence each other in the study area. In addition, the relationship between anaerobic biogeochemical activities (methanogenesis and sulphate reduction) and other physical factors such as sediment grain size and depth of water column was also examined. Sediment samples were collected from the 15 selected stations in Vembanad estuary, a Ramsar site in Kerala, India. The range of Bioturbation Potential, varied from 44.78 to 763.9 spatially and the difference reflects the variations in abundance, diversity and activity of benthic fauna. Although bioturbation was influenced by sediment grain size, bioturbation did not exhibit a significant influence over methane production and sulphate reduction in the Vembanad lake sediments. The effects of bioturbation on microbial activity depends on species-specific ventilation behaviour as well as the irrigation capacity, which suggests that in Vembanad lake, the sediment bioturbation caused less oxygen penetration, thus not affecting anaerobic microbial activity.

Keywords

bioturbation, methanogenesis, lake sediment, sulphate reduction

O14.4

Harmful algal blooms in the coastal waters of Northern Borneo, Malaysia: changes over the last 15 years.

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Abstract

The dinoflagellates *Margalefidinium polykrikoides* and *Pyrodinium bahamense* often form harmful algal blooms (HABs) along the coastal waters of Sabah, affecting the environment and human health, thus causing important economic losses. Here we report a monitoring record from 13 strategic sites throughout Sabah during 2004-2018 which showed the continuous occurrence of the two species; the observed *Margalefidinium* densities ranged from to 3 cells L^{-1} yr^{-1} in 2015−2018 to 83 cells L^{-1} yr^{-1} in 2004-2007, and *Pyrodinium* ranged 3 - 783 cells mL^{-1} yr^{-1} for the same periods. The overall trend is weak but significantly negative for *Margalefidinium* ($r = 0.28$, $p < 0.01$), and markedly negative for *Pyrodinium* ($r = 0.42$, $p < 0.01$). This shows that blooms of both species have decreased during the last 15 years. Generalized additive models (GAMs) identified oscillatory coexistence between the two species at c.a. 3-year intervals, suggesting potential niche differentiation and allelopathy effect in their sustained occurrences. Although HABs in other regions have been attributed to El Niño events in the tropical Indo-West Pacific, the record shows that most blooms in the waters of Sabah appear in periods of low sea surface temperature and higher rainfall. This mechanism offers new ways to better forecast and facilitate early detection of *Margalefidinium* and *Pyrodinium* HABs in the region.

Keywords

Margalefidinium, Pyrodinium, long term monitoring, Sabah, North Borneo

O14.5

A graphical user interface for fast and accurate workflow for cleaning, calibration and validation of continuous datasets

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Abstract

Often water-quality monitoring programs contain high-frequency continuous datasets. Because of the high complexity of these datasets, they often require cleaning and manual validation for removing datanoise, which generally is time consuming and cumbersome when dealing with large datasets. Post calibration may also be necessary when sensors are miscalibrated or when variables of interest are not directly measured (e.g. chlorophyll-a florescence). We developed the R package plygraph, which is a graphical-user-interface computer application for visual, accurate and fast cleaning (e.g. spike removal, filtering), validation and post-calibration. The tool is an opensource, R based Shiny application with optimized code for very large datasets. The tool is generic and offers the user both the choice of visual guidance, in which no coding is required, and scripting. As a test case, we applied this application to a high-frequency, long-term chlorophyll-a florescence dataset measured in the Scheldt Estuary (Belgium) at three locations. The continuous florescence data at each site was linearly calibrated to chlorophyll-a concentrations using lab-tested point samples. Interestingly, each site calibration resulted in a significantly different linear relationship (slopes 0.82, 1.48, 2.84), stressing the importance of site-specific calibrations. The calibration was accurate ($R^2 > 0.9$) despite using multiple sensors of the same type at each location, showing that the calibration variability between sites is mainly environmentally driven.

Keywords

Water quality monitoring, Continuous data, Data cleaning, Process automation

O14.6

Dynamic distributions of temperate forage fish at multiple spatiotemporal scales

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Abstract

Planktivorous fishes provide the essential link between planktonic production and fisheries. Whether reef-associated or pelagic, these forage fish exhibit fast growth, high fecundity and short lifespan, and are therefore crucial in fisheries ecosystems. The environmental drivers of their dynamic distributions were investigated at three spatiotemporal scales. Analysis of a decade of Reef Life Survey data off eastern Australia, revealed the biomass of planktivorous fish increased with latitude, while the abundance of herbivores declined (Holland et al. 2020). This transition was attributed to high benthic productivity at lower (sub-tropical) latitudes and low planktonic productivity at higher (temperate) latitudes in winter. As temperatures declined in autumn, planktivores moved away from reefs, likely seeking warmer waters offshore. This was evident in a related bioacoustics survey, which showed the distribution of forage fish was closely associated with temperature, with schools seeking warmer water offshore influenced by the East Australian Current along the shelf edge. Schools of planktivores may seek out warm water to improve physiological performance and generally avoid shallow coastal areas, where vertically constrained distribution increases their vulnerability to predation. The nocturnal behaviour of schools was revealed by multibeam sonar, as large schools descend to the seafloor around reefs. They rise higher in the water column during the day to feed, particularly around tall isolated structures. Overall distribution patterns have important implications for fisheries and for the predators which depend on regular and predictable access to prey.

Keywords

Multibeam, Planktivores, Artificial reef, Distribution

O14.7

Unravelling the predator-prey relationships between blacktip reef sharks and Sea turtle hatchlings: A stable isotope approach

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Abstract

The declining health of the world's coral reefs and tropical seas is adding pressure to vulnerable marine fauna. To guide mitigation efforts, understanding the complex dynamics of marine communities has become a top priority, particularly interactions involving threatened or endangered species. In a unique case study at one of Malaysia's most productive turtle nesting sites (Chagar Hutang Turtle Sanctuary (CHTS), Redang Island) we investigated the predator-prey relationships between the near-threatened blacktip reef shark, *Carcharhinus melanopterus*, and hatchlings of the globally endangered green sea turtle, *Chelonia mydas* using stable isotopes of $\delta^{13}C$ and $\delta^{15}N$. Being slower and more conspicuous swimmers than most reef fishes, hatchlings would presumably be a more accessible food source for sharks. We hypothesized that sharks would opportunistically feed on hatchlings during the turtle nesting season and, when available, sharks may favour turtle hatchlings over alternative prey. Our preliminary data shows that, there are high variations in the stable isotope values of the green turtle hatchlings collected from different nests ($\delta^{13}C$ values ranged from -19.5 to -15.9 ‰ and $\delta^{15}N$ values ranged from 6.9 to 7.4 ‰). The $\delta^{13}C$ and $\delta^{15}N$ for sharks ranged from -14.4 to -12.6 ‰ and 7.3 to 12.1 ‰ respectively. Meanwhile, stable isotopes for the other components of marine food webs were also monitored. It is expected that the blacktip reef sharks as many other predators, are generalists and do not depend on one prey species alone. In CHB, despite the discovery that some juvenile C. melanopterus may feed exclusively on turtle hatchlings when these are available, the sharks are not explicitly dependent on the hatchlings for their survival.

Keywords

Trophodynamics, ecosystem function, turtle conservation, ecological resilience

O15.1

From securing rights for small-scale fishers to property for "efficient" producers: the privatisation of scallop production in Sechura Bay, Peru

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Abstract

Sechura Bay in Northern Peru represents the most important location for the production of the Peruvian bay scallop (*Argopecten purpuratus*) – not only on national but also international level. This business emerged from the initiative of a hand full of small-scale entrepreneurial dive fishers finding ideal culture conditions in the large bay of Sechura, and is by now an important sector of the Peruvian economy, producing these molluscs mainly for the export market. In Sechura, it started as a rather unregulated, open access activity, where, as business rose, exclusive extraction and later territorial use rights have been granted formally under Peruvian law to small-scale fisher associations. While scallop culture is highly profitable under "normal" (environmental) conditions in Sechura Bay, it is, however, inversion intensive and a financially extremely risky business, for example when El Niño related dynamics cause scallop die-offs. After a *de facto* privatisation into the hands of those with the financial means, ability to take the risk, and other capabilities, the latest amendment of the law has paved the way for large-scale investors to hold all important property rights and to take control of the entire production process. This qualitative case study tells the story of the privatisation of the scallop business in Sechura Bay by referring to various institutional approaches. The story told is, on the one hand, conventional in the sense that a typical process of grabbing was observed: weak actors having to leave or being pushed out of a particular place or business. On the other hand, this particular process of grabbing took several turns: first, seemingly weak actors could secure their rights by achieving formalization and hence recognition from the Peruvian state, to then lose them succinctly due to a whole panoply of reasons to powerful newly entering players.

Keywords

privatisation, changes in property rights, Scallop bottom farming, Institutional change

O15.2

Activity-footprints, pressures-footprints, effects-footprints and response-footprints – walking the pathway to determining and managing human impacts in the sea

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Abstract

Determining the overall effects of human activities on the estuaries, coasts and seas , as a precursor to marine management, requires quantifying three aspects in space and time. These are: (a) the area in which the human activities take place, (b) the area covered by the pressures generated by the activities on the prevailing habitats and species, in which pressures are defined as the mechanisms of change, and (c) the area over which any adverse effects (and even benefits) occur. The effects-footprints in turn incorporates both the effects on the natural system and the effects on ecosystem services from which society extracts goods and benefits. Following this, the marine management response has to involve programmes of measures addressing the natural and human events producing adverse effects at those areas. These features, and the areas and periods covered, can be respectively termed activities-, pressures-, effects- and response-footprints, which have both spatial and temporal scales. This presentation explains the rationale behind this typology and proposes definitions for each of these four types of footprints. It emphasises the transboundary nature of these aspects and the need to include all of them in Maritime Spatial Planning, in Cumulative Impacts Assessment and in Strategic and Regional Environmental Assessments and their management.

Keywords

human impacts, DAPSI(W)R(M), marine management, , marine governance

O15.3

Exploring diverse decision-making strategies in a model of urban adaptation supported by coastal climate services

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Abstract

Climate adaptation strategies for cities experiencing or anticipating adverse impacts of sea level rise and climate-related coastal hazards, and also the success of implementation of these strategies, are shaped by decision-making mechanisms of relevant urban actors, by their values and preferences. Therefore, exploring diverse decision-making strategies is important for developing coastal urban adaptation models. We propose a discrete-time model of coastal urban adaptation where the city anticipates damages from sea level rise and related coastal hazards in future periods. However, the magnitude of future climate damage is inevitably uncertain. The coastal city can respond by developing and implementing a portfolio of climate adaptation measures. We embed three alternative modules describing the decision-making of the urban planner in the coastal adaptation model. They include the intertemporal utility maximization approach and two alternative descriptions of adaptive decision-making within the VIABLE modelling framework: the optimizing and the satisficing gradient actor behaviour, respectively. Dependent on the assumptions about actor strategies, and also on the values of key model parameters, the model yields versatile coastal adaptation scenarios spanning from the 'business-as-usual' (BaU) case with no adaptation action to a proactive adaptation. We also explore within the developed model the importance of support for urban adaptation by coastal climate services.

Keywords

coastal city, climate adaptation, sea-level change, coastal climate services

O15.4

Native peoples and the sea: when access to coastal management *is* heritage preservation

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Abstract

Marine resources are critically important to the cultural heritage of many indigenous peoples around the globe, including in the United States, New Zealand, Canada, and Australia, but colonialization displaced many of these peoples from active management of these cultural resources until recently. The paper focuses on the United States and New Zealand, both of which have legal obligations and policies in place to consider the role of native peoples—Native American tribes in the United States and the Māori in New Zealand—as part of their marine spatial planning processes. It examines three recent instances of Māori and tribal involvement in marine spatial planning. First, the State of Washington recently completed its marine spatial plan for its coastal waters, extending three miles out to sea. As part of this planning process, Washington was acutely conscious of its coastal tribes, especially the four coastal tribes with treaty rights to hunt and fish in "usual and accustomed places"—a right that encompasses a very large area of the sea off the Washington coast. Second, in northern California, the Tolowa Dee-ni' Nation has instituted its own marine spatial planning program in pursuit of co-management of two of California's marine protected areas. Finally, New Zealand recently completed the marine spatial plan for the Hauraki Gulf east of Auckland, incorporating not only Māori concepts of marine stewardship but also unprecedented levels of marine co-management. These three examples suggest that marine spatial planning provides a viable way to both incorporate and increase the sovereignty of coastal native peoples over marine resources while simultaneously allowing native conceptions of and frameworks for marine management to find legal expression, preserving and revitalizing cultural heritage while simultaneously opening new pathways of climate change adaptation.

Keywords

indigenous, MSP, culture, management

O15.5

How can coastal exposure and vulnerability assessments inform adaptation strategies to safeguard coastal and marine heritage?

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Abstract

Many studies assess coastal exposure and vulnerability using a range of tools, including indices formed by biophysical and/or socioeconomic indicators. The relevance of these studies for practical applications is often acknowledged. However, the literature offers little evidence or examples of where and how these assessments have been used to inform policy or decision-making. Information is particularly scarce on applications informing or supporting climate change adaptation strategies and virtually non-existent regarding coastal and marine heritage. This presentation reduces this knowledge gap by discussing examples of how coastal exposure and vulnerability assessments could be used to inform adaptation strategies that consider coastal and marine heritage. First, the outcomes of a systematic literature review will qualify the limited scope and coverage of coastal and marine heritage in the existing climate change adaptation studies. Then, using examples from the literature, we will discuss how coastal vulnerability assessments could inform adaptation strategies and, in turn, how these could consider coastal heritage. On the other hand, we will illustrate how threats to coastal heritage could be addressed through adaptation strategies informed by coastal exposure and vulnerability assessments.

Keywords

coastal vulnerability, adaptation, heritage, climate change

O15.6

Mapping ecosystem service potentials in southwest coastal Bangladesh-An expert-based matrix approach

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Abstract

Land uses/land covers (LULC) are closely related to the integrity of ecosystems and associated provisioning, regulating and cultural ecosystem services. Anthropogenic activities continuously influence ecological integrity and ecosystem services through changes in LULC. An integrative approach is essential to understand which ecosystem services (ES) are provided at which landscapes. Therefore, an ES scoring exercise based on local expert's knowledge was conducted in southwest coastal region of Bangladesh. The expert-based scoring values were linked in an 'ES-matrix' to the different land use/land cover (LULC) classes abundant in the study area. The LULC classifications were based on Landsat satellite image interpretation. The matrices were used to compile ES supply maps. A stratified simple random sampling method was employed to conduct a total of 36 expert's interview from six sub-districts (upazila) of southwest coastal Bangladesh. Our analysis revealed that high capacities of forest had the highest potential to provide a broad range of ecosystem services and to support ecological integrity whereas ES potential in urban areas was lowest. Results also show that crops, fish, shrimp, timber and fuelwood are important provisioning services in this area. High flow of provisioning services was mainly from forest and agriculture land use types. Regulating services flow was dominated in forest LULC followed by, agriculture, river and aquaculture. Results suggest that more natural LULC types are the important supplier of various ES in this region and therefore, should pay more attention to forest conservation in future. We conclude that the presented ES assessment can support decision-makers in the development of strategies for natural resources management at costal area of Bangladesh, support the development of nature protection plans by prioritizing areas with high ES potential and prepare measures to improve areas of low ES potential.

Keywords

Ecosystem Services, LULC, Expert Knowledge, Coastal Bangladesh

O15.7

Machine Learning of Sentinel-2 Earth Observation Data for Classification and Projection of Saltmarsh habitat

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Abstract

Based on earth observation (EO) data and machine learning (ML) algorithms, this research explores: 1) classification of coastal wetlands using Sentinel-2 multispectral data; 2) characteristics of environmental drivers that shape our coastal landscape; and 3) projection of saltmarsh zonation based on environmental drivers and machine learning algorithms. Results show that: 1) accuracy of classification based on the EO data is high in classifying major intertidal features such as mudflat, creeks, pioneer marsh and *Spartina* marsh. It is, however, less accurate in identifying mid-low marsh and upper marsh environments at 20 m spatial resolution and with the available range of spectral bands; 2) distributions of elevation, distance to land-water boundaries, hydroperiod and inundation frequency, obtained at 20 m resolution for *Spartina* marsh, mid-low marsh and upper marsh are very similar to each other. Distributions for pioneer marsh, on the other hand, are noticeably different; 3) the ML-based forward projection of wetland habitats successfully identifies elevation as the controlling environmental factor for saltmarsh establishment and demonstrates considerable efficacy (> 70%) when projecting all four saltmarsh types based on elevation, distance to land-water boundaries, hydroperiod and inundation frequency; 4) the observed low biodiversity in recently created saltmarsh through managed realignment could be a stage in its succession to climax; and 5) between k-Nearest Neighbours (kNN) and Random Forest (RF), kNN has a better performance when there are fewer environmental drivers, but RF undergoes more significant improvement when additional environmental drivers are included. The ML-based forward projection provides a method for identifying key environmental drivers of a saltmarsh system, leading to improved prediction of saltmarsh evolution in response to climate change. It also provides a way of examining the likely effectiveness of intervention strategies, such as designs of managed realignment sites.

Keywords

Machine Learning, Earth Observation, Modelling, Wetland

O16.1

Marine protection enhances kelp forest stability

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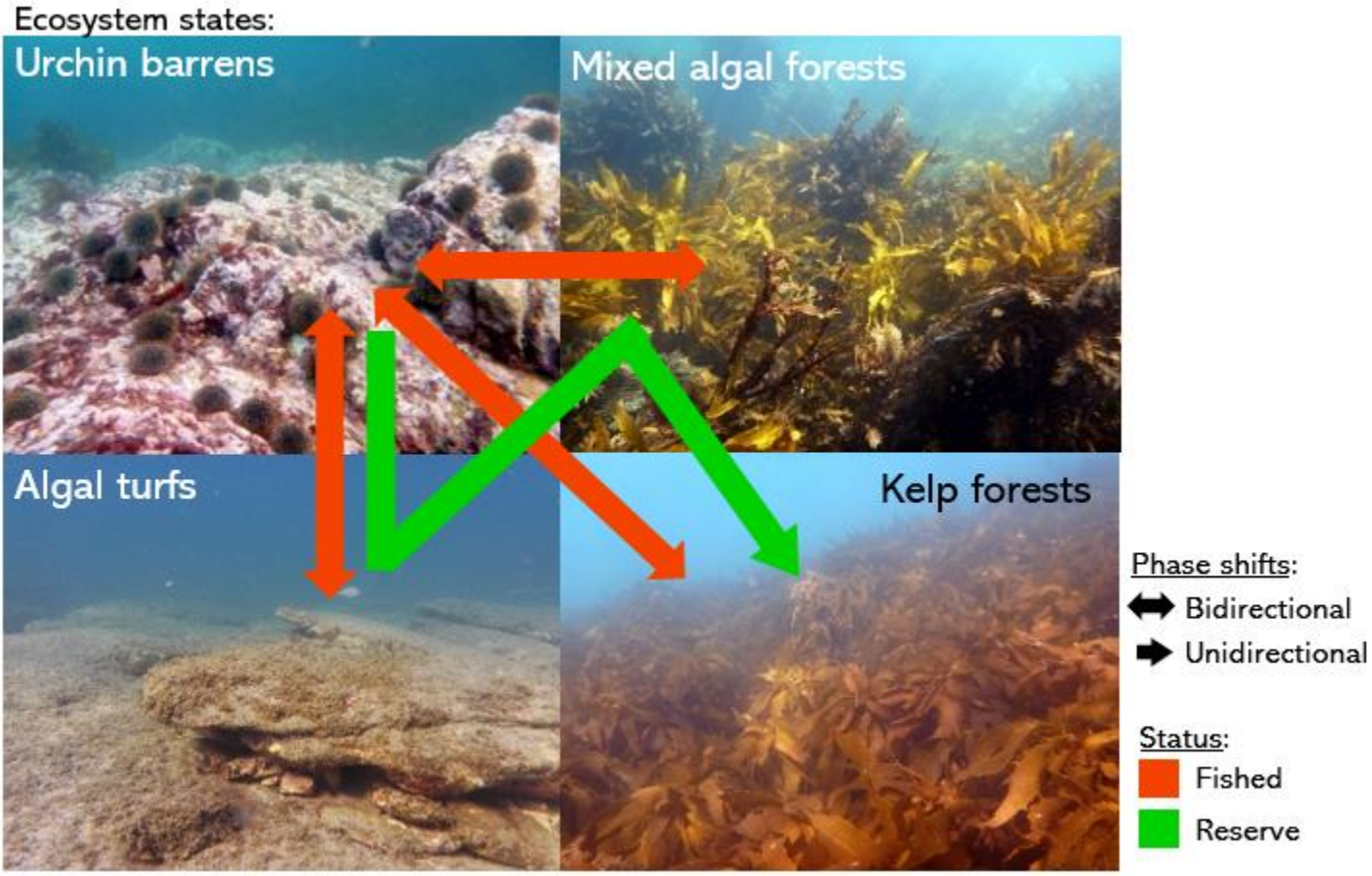
Abstract



Shallow temperate reefs are typically dominated by macroalgal forests, but overfishing may shift these highly productive ecosystems to denuded urchin barrens. No-take marine reserves can restore predatory interactions that generate cascading effects that reverse the shift to urchin barrens. However, the long-term effects of protection on kelp (*Ecklonia radiata*) forest ecosystem stability and the role of reserves in reversing or preventing shifts to algal turf has not been examined. Using 20 years of monitoring data from New Zealand's oldest marine reserve (Leigh; est. 1977), we explored temporal variation in ecosystem state under no-take protection and compared this to nearby fished reefs. Fished habitats fluctuated between urchin barren, algal turf, and occasionally algal forest states, while reserve sites were dominated by algal forests with a clear trajectory towards monospecific kelp forests. Protection increased the resilience and resistance of kelp forests through a net positive effect on

macroalgae, and a net negative effect on sea urchins and turfs. Stability was higher in the reserve, where fewer shifts occurred and ecosystem variation was smaller, compared to fished reefs. We conclude that long-term no-take protection is effective in promoting stable kelp forest ecosystems.

Keywords

Resilience / resistance, Phase shifts, Urchin barrens, Algal turfs

O16.2

Estimate of gathering of fish around artificial seaweed bed using environmental DNA analysis in Hiroshima Bay, Japan.

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Abstract

We have constructed an artificial seaweed bed using steel making slug since 2013 in Hiroshima Bay, the Seto Inland Sea, Japan. The purpose of this study is to estimate of gathering fish around the artificial seaweed bed using environmental DNA analysis. To identified fish species and populations, we set up 4 cameras in and out of the artificial seaweed bed to take 4 pictures per 1 hour. The surface and bottom seawater samples were collected every 50 - 100 meters around the artificial seaweed bed for eDNA analysis. The seawater was filtered using GF/F glass fiber filter paper and extracted DNA using a DNA extraction kit. We amplified and quantified eDNA using primers for some fish species.

The frequency of the appearance of fish in the artificial seaweed bed was 1.5 - 9.1 times higher than the sediment area, and the population of fish in the artificial seaweed bed was 4.8 - 50.3 times higher than the sediment area. The highest fish population occurred in November 2019, but the amount of seaweed was not high compared to the other months. In the artificial seaweed bed, we were able to identify 12 - 16 species of fish in 1 month, but only 8 - 10 species of fish surrounding the sediment area. It was *Sebastes* sp. that had the highest frequency and population in the artificial seaweed bed. The DNA concentration of *Sebastes* sp. was higher in and around the artificial seaweed bed than the surrounding sediment area. There was no difference in the eDNA concentration of *Sebastes* sp. in the artificial seaweed bed by season.

We concluded that the creation of the artificial seaweed bed enabled fish gathering more than the surrounding sediment area. There is no relationship between the population of fish and the amount of seaweed.

Keywords

Artificial seaweed bed, Fish gathering, Environmental DNA

O16.3

Using macroinvertebrates to assess the health of estuaries and coastal reefs

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Abstract

Human impacts can cause additional stress to that associated with the strong environmental gradients found on estuaries. Being able to accurately assess the health of these habitats is a major environmental concern. Here, we investigated the health of the Nervión-Ibaizabal estuary from 1996 to 2012. This estuary is under the influence of the Greater Bilbao Area, a heavily populated and industrialized area on the Atlantic coast of Spain. The +15-yr period investigated in our study includes major efforts from the local Government to restore the health of the Nervión-Ibaizabal rivers that cross the Greater Bilbao Area and feed the estuary. To quantify health, we defined the Reef Community Health Index (RCHI), an index based on rocky macroinvertebrate abundance. The RCHI is the community abundance-weigthed mean of the species sensitivity values. Sensitivity refers to the number of species at which the cumulative abundance/species frequency distribution curve changed convexity and started rising. Sensitivity provides an estimation of the minimum richness needed for a species to thrive, with decreasing sensitivity values associated with increasingly degraded sites. Our results showed that the largest RCHI values were outside the estuary area of influence, while the lowest RCHI values were in the estuary most inner section. In the +15-yr period investigated, RCHI values increased over 100% in the outer region of the estuary, a trend associated with the decrease of major pollutants and improved environmental conditions resulting from the restoration efforts. Yet, neither the inner section nor the rocky communities outside of the estuary showed signs of improvement. Our results suggest that the RCHI takes into account both natural and human-driven conditions and provides an estimate of the overall health of the system. The RCHI is therefore suitable for large-scale geographic and temporal health assessments of marine benthic communities.

O16.4

Environmental compensation for coastal biodiversity and ecosystem services: A flexible framework that addresses human well-being

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Abstract

Continued loss of biodiversity and ecosystem services creates an urgent need to halt environmental degradation, not least in coastal areas. Environmental compensation has been suggested as a potential tool to reduce or neutralize this development. When applied as a last step in a mitigation hierarchy, the suggested benefit of environmental compensation is that it focuses on the resource itself, so that compensation is "paid" to the public in terms of environmental resources rather than in financial terms. However, estimating the compensation need is inextricably linked to the "value" of what is lost; which losses in values should be compensated and how? Failure to recognize the full damage of environmental degradation is known to lead to poor decision-making both publicly and privately, as the limited subset of values taken into account by markets still tend to be decisive for when and how environmental assets and flows are consumed.

We present a framework for estimating residual losses in connection to a human impact, identifying compensation needs and exploring compensation options. The framework is based on the cascade model, identifying structures, functions, ecosystem services, and benefits damaged. The theoretical principle is to compensate for *all* impacts by matching resource loss with subsequent resource gain, however balancing this with flexibility in selecting appropriate compensation options. Rather than a step-by-step guide, this offers resource managers a structure for analyzing how a coherent resource-based compensation can be formulated in relation to agreed-upon compensation objectives, such as no net loss. The framework is applicable in a variety of environmental settings and contexts (e.g., expected damage *ex ante* or actual damage *ex post*), but here, we demonstrate it by an illustrative case study involving eelgrass habitat loss in a coastal setting.

Keywords

biodiversity offset, cascade model, ecosystem services, habitat loss

O16.5

The sedimentological evolution of a non-engineered coastal wetland restoration scheme

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Abstract

There is growing evidence that managed realignment (MR) sites, implemented to compensate for the loss of coastal wetlands, have lower biodiversity than natural saltmarshes as a result of the site's physical functioning. However, previous analysis of the sedimentological processes in MR sites has focused on sites that have undergone engineering work and landscaping during site construction. As a result, these sites may be influenced by the design processes and not representative of the sedimentological evolution without these interventions. To assess the evolution of MR sites without the influence of engineering work, we present analysis of the rate and patterns of sedimentation in a non-engineered MR site. Measurements were taken at Cwm Ivy Marsh, UK, on the northern coast of the Bristol Channel, which breached in August 2014 as result of the defensive sea wall no longer being maintaining. Consequently, there was no landscaping carried out prior to site breaching. Measurements of the change in bed elevation and suspended sediment concentration (SSC) were taken and compared to high resolution (<0.2 m/pixel) digital surface models and orthophotography (<0.05 m/pixel), collected using an Unmanned Aerial System. The accretion of the sediment above the terrestrial surface, and the subsequent geochemical evolution, was also identified through analysis of sediment cores.

Results indicate a sedimentation rate of 3-7.5 cm/year. Subsurface geochemical profiles indicated little evidence of reduced hydrological connectivity, which has been found in engineered MR sites. The SCC decreased during the flood and increased during ebb tide whereas bed elevation increased and then decreased during the flood tidal phase, with this pattern repeating during the ebb tide. These findings are discussed in terms of the importance of studying the sedimentological processes in MR, and provide an insight into the evolution of older areas historically breached during storm and extreme weather events.

Keywords

Wetland restoration, Saltmarsh, Sedimentation

O16.6

Exploring possibilities for subtidal seagrass restoration in the Dutch Wadden Sea

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Abstract

Seagrasses provide important ecosystem services, such as increasing biodiversity, and providing coastal protection. In the 1930s, the wasting disease caused the degradation of subtidal eelgrass (*Zostera marina*) beds throughout Europe. Although many meadows have recovered, the extensive seagrass beds in the Dutch Wadden Sea are still extinct. Seagrass restoration in general has proven to be challenging due to the dynamic environment where seagrasses usually occur. In systems with seagrass, sediment stability is increased by dense root and rhizome mats, while external forcing is reduced by shoot and leaf tissue. These tissues also trap particles from the water column, leading to clearer water and therefore more light. Once seagrass is lost, the lack of feedbacks make restoration difficult. In my PhD project, I will study possibilities for the reintroduction of subtidal eelgrass in the Dutch Wadden Sea. First, I will identify suitable habitats to support evidence-based restoration attempts. Based on water depth and sediment stability, we have selected ten possibly suitable locations. Here, we will measure environmental parameters like light availability, sediment movement, current flow, and wave height for a year. These measurements will provide the foundation for the development of a habitat suitability map for eelgrass in the Dutch Wadden Sea. Based on literature, environmental parameters will be translated into suitability indices, indicating how suitable different areas are. Multiple layers of these parameter suitability maps are then integrated into the habitat suitability map, of which I will present some preliminary data at this conference. Based on the map, I will further develop restoration experiments in mesocosms and *in situ*. Experiments will be geared towards reinstalling scale- and density-dependent feedbacks, which will later be translated in applications such as planting densities, patterns and sizes. My research will contribute to taking first steps towards reintroducing subtidal eelgrass in the Dutch Wadden Sea.

Keywords

Zostera marina, eelgrass, habitat suitability map, positive feedback

O16.7

Improving groundwater dynamics in new tidal marsh restoration projects: a modelling approach

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Abstract

Along estuaries and coasts, tidal marsh restoration projects are increasingly being executed on formerly embanked agricultural land to regain the ecosystem services provided by tidal wetlands. There are, however, more and more indications that restored tidal marshes do not deliver these ecosystem services to the same extent as natural tidal marshes. In particular, we found that marsh restoration on a compacted agricultural soil (which has a very low porosity and hydraulic conductivity) leads to reduced depth of groundwater level fluctuations, which may imply decreased soil-water interactions, reduced biogeochemical cycling and impaired vegetation development.

Using a modelling approach, we aim to determine design practices to optimize groundwater flow in new marsh restoration projects. A numerical groundwater model for a restored tidal marsh was set-up in HYDRUS, using a 2D vertical model domain representing a creek and marsh cross-section. The model enables variably saturated flow calculations in dual porosity media. Input parameters for the model were obtained by soil sampling from a restored marsh (Lippenbroek, Scheldt estuary, Belgium) and laboratory measurements of saturated hydraulic conductivity and soil water retention curves. Simulated results are in good agreement with *in situ* measured groundwater levels in monitoring wells. The resulting model was used to calculate fluxes of groundwater and solutes towards creeks in between tidal inundations and to run scenario analyses for different design options, including:

1. Soil amendments: As input for the model, we used soil hydraulic properties observed from a mesocosm experiment on soil amendments (ploughing and adding organic matter). The model showed that these soil treatments affect the depth of groundwater level fluctuations.

1. Creek excavation: Model scenarios with different interspacing between initial creeks, show that groundwater level fluctuations and fluxes towards creeks increase with increasing creek density.

Keywords

marsh restoration, groundwater flow, modelling, soil compaction

O17.1

Coastal ocean assessment for sustainability and transformation (COAST Card)

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Abstract

The COAST Card project is developing a stakeholder-driven tool that monitors, forecasts, and reports the effectiveness of management decisions on coastal and ocean sustainability. Massive changes in climate, population, pollution and consumption patterns place coastal and ocean systems at increasing risk, so a new set of robust and transformative tools are needed to produce well-balanced policies that will lead to improving environmental resources at a global scale. COAST Cards will do this by merging three tools: 1) environmental status assessment through socio-environmental report cards, 2) societal guidance provided through social network analysis and 3) prioritized actions identified with system dynamics models. The synergistic impact of merging these three tools into the COAST Card will enable forecasting the effectiveness of future management regimes on coastal ecological, economic and social aspects. We have assembled researchers from the United States, Norway, Philippines, Japan and India into the following teams: leadership, stakeholder engagement, dissemination, evaluation and data management. We are developing the COAST Card tool in five iconic locations: Chesapeake Bay on the east coast of the United States, Manila Bay in the Philippines, Tokyo Bay in Japan, Ishigaki Island/Sekisei Lagoon in Japan and the Goa coast of India. Each study site is engaging a suite of stakeholders from governmental agencies, academic institutions, industry and businesses, non-governmental organizations, and interested members of the public. There are some values that are ubiquitous in all study sites like fishing, shipping/port operations, habitats, tourism/recreation and cultural values. Similarly, there are some threats that are ubiquitous like pollution, climate change, population pressure. This multi-year project is supported by the Belmont Forum, a consortium of scientific funding agencies focused on developing transdisciplinary and transnational collaborative research actions.

Keywords

COAST Card, Report cards, Social network analysis, System dynamics model

O17.2

System dynamics based modeling for the Chesapeake Bay: The case of Potomac watershed

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Abstract

Since 2006 Chesapeake Bay Report Cards have been catalyzing positive action in the Bay. However, providing quantitative recommendations to improve environmental conditions reflected by the report card grades has been a challenge. Generic recommendations and best practices are included, but the impacts on complex systems and interactions with socio-economic factors are not fully described. Capitalizing on the existing report cards, system dynamics modeling has been introduced to capture the interaction across the ecosystem, governance, economy, and people and culture of the Chesapeake Bay. The system dynamics modeling could help bridge the observed gaps in report cards by quantifying relationships among indicators, enabling varied management scenarios to be assessed, and leading to recommendations that promise better outcomes. In this paper, we present a pilot system dynamics model developed for the Potomac watershed, a watershed of the Chesapeake Bay. Using the system dynamics model, we assessed how pollution sources such as agriculture and mining interact with the socio-economic factors of the watershed to determine the environmental condition of the region.

Keywords

COAST Card, System Dynamics Model, Chesapeake Bay, Potomac

O17.3

Using social network analysis in the coastal ocean assessment for sustainability and transformation (COAST card) framework

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Abstract

The Coastal Ocean Assessment for Sustainability and Transformation (COAST Card) approach encourages stakeholder engagement and transdisciplinary collaboration in order to produce cost-effective and balanced pathways toward resilient communities and ecosystems. Stakeholder participation and collaboration is critical and careful stakeholder selection and engagement is needed throughout. However, research has shown that stakeholders only collaborate to advance their agenda while having little interest or having limited individual capacity to contribute towards solutions. One way of addressing this is through Social Network Analysis and Socio-ecological Network Analysis, which are increasingly being used in natural resource governance. It has been used and applied in many systems around the world in the context of coupled human and natural systems, social-ecological systems, sustainability and resilience, and collaborative governance, among others. These network approaches can identify the structure of social connections between and among different stakeholders and ecological units allowing for the prioritization of actions that have the greatest potential for stakeholder buy-in. It can be used to improve communication, enhance social learning, and promote collaborative actions through the understanding of societal barriers and opportunities by identifying relationships, information flow, and key individuals that can influence decision-making to improve scores. SNA can also be used to evaluate engagement processes by showing how connections form and change over time. The merging of social network analysis, socio-environmental report cards, and system dynamics modeling in the COAST Card framework will enable the assessment of coastal and ocean systems, provide guidance on optimal cost-benefit solutions to maintain or improve the health of these systems, and identify the actors best placed to deliver these solutions. Getting the right people, armed with publicly available synthesized information, informed by robust models, and having trusted relationships through the co-production of COAST Card can and will catalyze positive socio-environmental change.

Keywords

COAST Card, social network analysis, governance, co-production

O17.4

Using Socio-environmental report cards in the Coastal Ocean Assessment for Sustainability and Transformation (COAST Card) framework

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University of Maryland Center for Environmental Science, USA

Abstract

The Coastal Ocean Assessment for Sustainability and Transformation (COAST Card) framework provides a mechanism for regular reporting and accounting of global change impacts through indicators that are monitored and assessed periodically. It merges three tools: socio-environmental report cards, system dynamics modeling, and social network analysis. This presentation will give a brief overview and evolution on the use of report cards in socio-environmental management and present case studies of how they've been used in iconic locations all over the world. Report cards are stakeholder-driven assessment and communication products that provide numeric grades based on the performance of environmental, social, and economic indicators against predefined goals or objectives. Report cards have been a flagship of the University of Maryland Center for Environmental Science (UMCES) for 15 years. They are developed through intensive stakeholder workshops that identify values and threats from diverse perspectives. They are developed through subsequent iterative workgroup activity that results in: (1) stakeholder consensus of the main values and threats in socio-ecological systems, (2) indicators to measure these values and threats, (3) thresholds that define the desired condition of these indicators, (4) delivery of results, findings, and recommendations in a concise and easily understood format, and (5) engagement that results in improved scores. Repeated enables tracking of results in response to management actions, investments, new developments, and climate change. A challenge for report cards has been the ability to provide quantitative recommendations to improve conditions reflected by report card grades. Introduction of system dynamics modeling and social network analysis in the COAST Card framework will bridge this gap by converting qualitative information into quantitative recommendations and determining how actions should be implemented in the most cost-effective manner and by whom.

Keywords

COAST Card, report cards, socio-environmental, sustainability

O17.5

Chesapeake Bay: A case study in resiliency and restoration

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Abstract

Chesapeake Bay is the largest estuary in the United States and arguably the best studied estuary in the world. Situated in the mid-Atlantic region and with a watershed sprawling over several regulatory jurisdictions with competing interests, the Bay presents a unique case study in resource management. The characteristic properties of Chesapeake Bay, with its thousands of kilometers of shoreline and shallow, nutrient-retentive waters creates its two most important features: its productivity and vulnerability. The fisheries of the Chesapeake Bay and productive farmland, early drivers of settlement and subsequent economic growth in the region, continue to play a significant role in management of the watershed. Since European colonization, shifting land-use patterns, from agriculture to urbanization, and the associated input of excessive nutrients, sediments, and toxins, have had a deleterious impact on the Bay's water quality and thus overall ecosystem health. In 1972, heavy rainfall and runoff associated with Tropical Storm Agnes pushed a teetering ecosystem into near collapse. This event was coincident with emerging landmark environmental regulation at the Federal level. In response, local research institutions began documenting the declining health of the ecosystem and the Chesapeake Bay Program was established in 1983. Continuing research and the evolving challenges associated with climate change have resulted in a constantly evolving regulatory and management regime aimed at improving the health of the Chesapeake Bay region and its citizens. A historical survey of the unique regulatory and management challenges associated with Chesapeake Bay is instructional, as it highlights that diverse stakeholders can use research to drive policy and ultimately affect quantitative improvements in ecosystem health. Agility in management and policy is key, given the dynamics of population growth and evolving demands and challenges within the ecosystem.

Keywords

COAST Card, restoration, socio-environmental report cards, environmental literacy

O18.1

Observation of dolphin (Orcaella brevirostris) along the Mahakam river in East Kalimantan, Indonesia.

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Abstract

River dolphins and porpoises are two of the world's most endangered species. The Mahakam River's dolphin population and distribution spread far upstream and into its tributaries. Mahakam dolphins may search for food in these remote areas of the river due to the effects of ocean tides and floods. Since these dolphins are often captured and unable to return to their natural habitats, sub-populations have developed. In East Kalimantan, dolphin monitoring is performed infrequently and inconsistently. Monitoring necessitates precision and repeating measurements of the same methodology that is being built on a regular basis. This research used a parallel monitoring survey in three locations (Kedang Kepala, Pela, and Kedang Rantau), which meant we split into three survey teams and collaborated on the project at the same time. The monitoring was completed in three months, with each month requiring a six-day field survey. In regular field surveys, we conduct three types of monitoring surveys: morning, daylight, and afternoon. Dolphins are easier to spot in the Mahakam river, especially in the Kedang Kepala estuaries, meaning that they aren't bothered by high ship traffic or turbidity counting. When they leave this habitat, it is predicted that they will have a major impact on the food supply. Food is most often found in estuaries, where dolphins are more likely to come across it. For dolphins, flooding and tidewater are major issues. They travel upstream and are always unable to return to their starting point. Dolphins will migrate upstream when the Mahakam river tide is high. The dolphin population drops into the pit and into the swamp area when the water recedes.

Keywords

Mahakam river, Orcaella brevirostris , forage , trapped

O18.2

Spatio-temporal evaluation of Japanese eel habitat using eDNA and fresh water quality in Japan

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Abstract

Japanese eel (*Anguilla japonica*) is traditional fishery resource and also significant indicator species of watershed ecosystem health in Japan. The whole life history of the eel is directly affected by watershed, estuaries and coastal sea ecosystem.

Unfortunately, critical decreasing of genius *Anguilla* resource is not only the Japanese domestic issue but also serious international concerns. In recent years, watershed fragmentation by dam, decreasing (destruction) of suitable habitats, and change of water qualities are major concerns about their habitat degradation.

In this study, we estimated spatio-temporal changes of Japanese eel distribution in whole Japan. Then we tried to find out the cause of the decreasing of the eel resource based on statistical analysis and GIS procedures. Additionally, we conducted an ecosystem monitoring by using Environmental DNA (eDNA) analysis to detect the habitat of the Japanese eel.

The objectives of our research are as follows. 1)The construction of a nationwide scale GIS database on long term eel habitat distribution, statistics of fisheries and watershed environmental parameters with freshwater quality. 2) Analysis of the spatio–temporal changes of eel habitat and its relation to the watershed characteristics. 3) GIS mapping to understand the present status of Japanese eel distribution and to visualize ideal candidate sites for the Japanese eel habitat restoration. 4) As the assessment area, we are particularly interested in “The Seto Inland Sea of Japan”. We adapted an ecosystem monitoring approach using the eDNA analysis in this area.

Through these four steps, we evaluated the changes of Japanese eel habitats, and detected some remarkable area including habitat loss and degradation. Finally, we discussed the potential of eDNA analysis on Japanese eel habitat monitoring and restoration sites for Japanese eel in an effective and efficient manner.

Keywords

Japanese eel, eDNA, Japan, GIS

O18.4

Biophysical studies of reef fish self-recruitment and connectivity in Micronesia

Eric Wolanski

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Abstract

Calibrating against a 30-year time series of larval recruitment of rabbit fish, an herbivorous coral reef fish, on the island of Guam, tropical western Pacific, I developed a high-resolution biophysical model that includes directional swimming. It reveals how meso-scale turbulence and ENSO-driven changes in the ocean circulation impact on the population dynamics of rabbit fish. ENSO drives island wakes that enhance the capacity to retain locally spawned larvae, and meso-scale turbulence generates much variability at time scales larger than the Pelagic Larval Durattion. Using the same model, I quantified the ENSO-driven variability of grouper fish self-recruitment in Palau, Micronesia. Using an altimetry-driven advection-diffusion oceanography model, I mapped for 40 mass spawning events spread over 10 years the grouper fish connectivity in Micronesia and I showed that meso-scale turbulence is the dominant process controlling connectivity and not the mean oceanographic currents. This finding applies also in the Galapagos archipelago, the Spratly Islands archipelago and the Coral Sea fringing the Great Barrier Reef.

Keywords

Fish recruitment, Connectivity, ENSO, Islands

O18.5

Variations in biogeographic composition and functional structure of estuarine-associated fishes among ecoregions in the Japanese Archipelago

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Abstract

While the relationships between functional guild and biogeography of estuarine-associated fishes are largely understood, the factors affecting the structure of ecological guilds at the regional level remain unclear. Past studies have indicated that differences in climate regions may affect faunal assemblage structures. Building on this data, and focusing on the Japanese Archipelago, the present study hypothesized that differences in climate region affect the biogeographic composition and guild structure of fishes in estuaries. To test this hypothesis, the following steps were taken: 1) construction of faunal list of fish species (excluding freshwater fishes) in estuaries of Japan based on literature records; 2) biogeographic classification of these fish species into three categories (cool-temperate, warm-temperate, and tropical); 3) classification of these species into twelve estuarine-use functional guilds; and 4) statistical analysis to clarify differences in biogeographical and functional structure of these guilds among five ecoregions in Japanese waters.

We found that the percent contribution (based on the number of species) of each biogeographic category differed significantly among regions. Moreover, a permutational analysis of variance with local assemblage data for guild components (percent contribution of each guild in number of species) detected significant differences between the guild structures of northern Japan and those of other regions.

These results suggest that differences in marine climate regions affect biogeographic composition and guild structure of fishes in Japanese estuaries. In addition, a regional analysis of guild structure showed that the differences in northern Japan were driven more by diadromous than by marine species. This study highlights the importance of differences in marine ecoregions with respect to assemblage structure and ecological function of fishes in estuaries.

Keywords

Biogeography, Functional guild, Estuarine fishes, Japan

O18.6

Incursion and reproductive strategy of a planktonic copepod *Acartia japonica* in Sagami Bay, Japan

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Abstract

The incursion and successful establishment of non-native zooplankton species can significantly alter plankton community composition. The accumulation of biological and physiological knowledge in these species are essential for understanding the mechanisms of their dispersal and successful establishment in their non-original habitats. Recently, we found the occurrence of a planktonic copepod *Acartia* (*Odontacartia*) *japonica*, Mori, 1940 as a newcomer at Manazuru Port in Sagami Bay, Japan, where has been well studied and monitored for over two decades. The present study investigated the annual and seasonal variation in abundance of the species in water column at Manazuru Port in Sagami Bay, based on the monthly monitoring six years from 2011 to 2016, to clarify the appearance pattern of the newly occurring copepod. We also examined the *in-situ* egg production of the species, to understand its reproductive traits in the field.

Acartia japonica has appeared in water column at Manazuru Port only from summer to autumn every year after 2013. The species has disappeared from late autumn for 200-300 days, and has appeared again in the next summer. The water temperature measured during its occurrence period suggests that the copepod is a warm stenothermal species. The species produced subitaneous and diapause eggs during its occurrence period in the field. Suibitaneous eggs were mainly produced from August to September (summer), which hatched immediately and may increase the individual number of the species. Diapausing eggs were produced from September to November (autumn), which showed an ability to survive over 300 days under ambient-water temperature in the laboratory. Therefore, diapause eggs may play a role to connect the temporally divided populations of the species in each year. Continuous occurrence in every warm season and diapause egg production suggests successful establishment of the species population at Manazuru Port in Sagami Bay.

Keywords

non-native species, seasonal appearance, egg production, resting egg

O19.1

The influence of pre- and post-breach conditions on the sedimentological evolution of coastal wetland restoration schemes: are we building saltmarshes on carparks?

Jonathan Dale

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Abstract

Coastal wetlands are globally important environmental systems, offering a range of ecosystem services including wildlife habitat and coastal flood defence. However, these environments are threatened by erosion and rising sea levels, along with reclamation and degradation by anthropogenic activity. To compensate for the loss of wetland habitat as a result of sea level rise, and to improve the sustainability of flood defences, coastal engineers have implemented a number of engineering projects to re-create, restore and construct new intertidal habitat. The most popular method of habitat restoration is a procedure known as managed realignment (MR); the process of re-locating the land / sea border by de-embanking, lowering or breaching flood defences, thereby allowing inundation of the coastal hinterland. However, there is growing evidence that saltmarshes in MR sites have lower biodiversity and ecosystem service delivery than natural sites, which may have consequences for the level of coastal flood defence and ecosystem functioning. Differences in the physical sediment characteristics and sub-surface hydrology and geochemistry have been proposed as possible explanations for these differences. This presentation reviews the current knowledge of the influence pre- and post-site breaching sedimentological conditions have on the physical evolution of MR sites. Findings are discussed in terms of the areas where further research is required, outlining what is being done to address these knowledge gaps. Addressing these shortcomings is of particular importance as global communities face the implications of future climate change and attempt to sustainably defend against sea level rise and increased storminess, whilst compensating for habitat loss and degradation.

Keywords

Wetland restoration, Saltmarshes, Managed Realignment

O19.2

Mangrove vulnerability to sea-level rise under varying environmental conditions: A bio-morphodynamic modelling study involving vegetation dynamics and coastal profile change

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Abstract

Regional variations in coastal environmental conditions (such as sediment supply, tides and waves) lead to different coverages and behaviours of mangrove forests. Yet it remains highly uncertain how mangroves in various environmental settings will respond to accelerating sea-level rise. Existing projections primarily focus on vertical accretion to offset sea-level rise impacts and on opportunities for lateral migration. However, the mechanisms controlling sediment transport and accretion across mangrove forests and how this links to coastal profile change and mangrove survival still need to be further investigated. Here we use a bio-morphodynamic model that couples mangrove dynamics, hydro-sedimentary processes and morphological change to systematically explore mangrove vulnerability under a wide range of environmental conditions based on mangrove ecosystems around the world. We first investigate coastal profile evolution and mangrove forest dynamics under a stable mean water level and then implement sea-level rise based scenarios following IPCC predictions. We show that tidal range and sediment supply play a key role in determining coastal profile evolution and mangrove characteristics. A larger tidal range increases landward sediment supply and raises sediment concentration across the whole tidal area. Spring-neap tidal cycles create a larger mangrove zone and cause faster coastal progradation; this is due to an extensive flooding area during spring periods and a calm hydrodynamic environment during neap periods. Moreover, results show that small waves enhance profile propagation but may also limit mangrove seaward expansion due to a higher bed shear stress at the seaward fringe of the mangrove forest. At last, we show how different rates of sea-level rise can further drive mangrove dynamics and morphological evolution in different environmental conditions. Our study provides in-depth insights into future mangrove development, which will help to manage the coastal environment in the face of global change.

Keywords

bio-morphodynamic modelling, mangrove vulnerability, sea-level rise

O19.3

Effective design of managed realignment schemes can reduce coastal flood risks

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Abstract

Managed realignment (MR) constitutes a form of nature-based coastal adaptation and involves the abandonment of existing sea defences and their relocation further inland, allowing the (re)creation of vegetated intertidal habitats between old and new lines of defence. Some evidence suggests, however, that the desired coastal protection function of MR schemes can be limited, with scheme design not leading to expected levels of high water level (HWL) attenuation. Here we analyze the effects of scheme design on high water level attenuation rates within the Freiston Shore MR site, Lincolnshire, UK.

For this purpose, we implemented a 2-D hydrodynamic model, calibrated and validated against field measurements of equinoctial tides between August and October 2017, both within, and seaward of, the Freiston Shore MR site. The effects of scheme design on HWL attenuation were studied by running the model with six different scheme design scenarios, differing in terms of breach design and water storage area.

Our results show that varying the design of the Freiston Shore MR site had a significant effect on the site´s HWL attenuation capacity. When the tidal prism was varied by changing the number and size of breaches and the storage area kept constant, modelled HWL attenuation rates increased with decreasing tidal prism. However, the largest HWL attenuation rates (> 10 cm km^{-1}) were obtained if the MR area was increased approximately two-fold, and by approximately three quarters. Therefore, only larger sites may provide effective coastal protection.

Negative correlations between average high water depth within the MR and average HWL attenuation rates, however, suggest that extreme events may overwhelm the capacity of even the largest MR sites to provide effective coastal protection. Future research, through additional model runs, aims to assess the effectiveness of the range of site designs at Freiston Shore MR when impacted by extreme events.

Keywords

coastal wetland, coastal protection, restoration, managed realignment

O19.4

The willow in the intertidal reduces flow velocity even during winter with possible implications for tidal wetland restoration and nature-based adaptation to SLR

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Abstract

Willow floodplain plantations are proposed as part of plans to create tidal wetlands for ecosystem-based flooding defence with high potential since they grow high in the intertidal. Willow forests characterize riparian floodplains in Europe up to the river mouth, e.g., in tidal wetlands along the Scheldt and Rhine-Meuse estuaries, Ems, Weser, Elbe, and the Thames estuary. Today, they are largely fragmented and have to be restored according to conservation polices.

We studied what conditions along the estuarine salinity and flooding gradient two keystone willow species, *Salix alba* L. and *Salix viminalis* L., tolerate with tidal treatment and tested biophysical traits and bending capacity. Second, effects of living juvenile willows on flow velocity were studied in summer and winter in flume tests.

Permanent and semi-permanent flooding of roots and periodic flooding of shoots reduced biophysical traits but partial submergence did not affect biophysical traits. Shoot diameter and length was larger for *S. viminalis* resulting in higher bending capacity but *S. alba* showed more consistent results. In the flume, flow velocity decreased within the leafy willow canopy but was less reduced above and below the canopy during summer whereas in winter, flow velocity inside the leafless canopy was reduced but less reduced compared to summer. However, flow reduction above the canopy and near bed flow reduction is greater during winter when storm surges meanly occur. Generally, flow velocity was most reduced directly behind the willows and increased with vegetated test section length.

The willow is useful for tidal wetland restoration and may be a supplemental feature for nature-based adaption to SLR with increasing flooding when applied high in the intertidal in front of the dikeline. More research in the large flume and the field and on effects of harsh short time salinity increases (e.g., during storm surges) on the willow is needed.

Keywords

tidal forest, willow, coastal defence, wetland restoration

O19.5

Coastal wetland inland migration in response to sea level rise: field and modelling evidence

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Abstract

Coastal wetlands, including intertidal saltmarshes and mangroves, are highly valuable ecosystems which are sensitive to environmental changes, including global sea level rise (SLR). Coastal wetland loss from accelerated environmental forcing could significantly impact global carbon budgets and increase coastal flooding. However, estimates of coastal wetlands loss with future SLR diverge significantly between different researchers. Some suggest global losses of up to 90% by 2100, others suggest much lower global losses (or even gains) due to the wetlands' ability to persist through vertical sediment accretion with increasing SLR rates, as well as to migrate inland in response to SLR. While vertical sediment accretion in coastal wetlands has been extensively studied in recent decades, the process of wetland inland migration has received little attention. Nevertheless recent modelling suggests that inland migration could be the main driver for the ability of coastal wetlands to adapt to future SLR.

This paper reviews existing field evidence for the process of coastal wetland inland migration, analyses the degree to which existing modelling approaches are supported by local field data, and discusses the environmental drivers for landward migration. It considers the implications of these findings for the ability of coastal wetlands to adapt to future accelerated SLR. The combination of field and modelling evidence from various locations and spatial scales suggests that future coastal wetlands, subject to inland migration in response to SLR, may be less persistent than coastal wetlands as we know them. They are likely to be subject to rapid landward shifts of the upper wetland boundary and the simultaneous loss of lower wetland areas. The changing nature of future coastal wetlands raises questions with regards to their ecological value and the provisioning of ecosystem services.

Keywords

Coastal wetlands, Sea level rise, Adaptation, Inland migration

O19.6

Tracing the sources of organic matter in mangrove sediments and its implication to sediment provenance in Vanga Estuary, Kenya.

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Abstract

Sediment accumulation in mangroves is vital in the growth of mangrove surface elevation with respect to sea level rise. Sedimentation within mangrove forests is a combination of both autochthonous (*in situ*) and allochthonous (terrigenous) material input and deposition. We utilized C/N, TOC and $\delta^{13}C$ to disentangle sources of organic matter in sediments as a proxy for sediment provenance. We evaluated sediment samples collected along the entire gradient of the transboundary Umba River from mouth to source in seven stations during both the dry (February - March 2019) and wet season (May - June 2019). We broadly categorized the sediment samples as either riverine, estuarine or marine according to their sampling locations. A Bayesian Stable Isotope Mixing Model in R-program (SIMMR) was used to estimate the proportional contribution of different potential sources of organic matter in surficial sediments to the mangroves of Vanga in Kenya. The C/N and $d^{13}C$ were significantly variable ($p<0.05$) between the stations and the broad categories. However, they were not significantly variable between the seasons. $d^{13}C$ was relatively depleted in estuarine and riverine samples compared to agricultural soil and oceanic samples. C/N ratios were >10 in all stations during both the dry and wet season reflecting a pronounced terrestrial origin of organic matter. The model results showed that the sediment OM in the delivered in the Vanga estuary, had varied sources with discernible mixing. Additionally, riverine-derived OM was proportionately the dominant source of sediment OM compared to other sources during both the dry (60%) and wet season (70%). This indicates the great influence of the Umba River and its catchment on the downstream mangrove habitat. This study forms part of the baseline information needed to set up and demarcate a proposed joint transboundary conservation area (TBCA) between Kenya and Tanzania inclusive of the Vanga mangrove patch.

Keywords

Sediments, Organic matter, Stable isotopes, Umba River

O20.1

Comparison of reef communities on natural and artificial habitats in the Atlantic region.

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Abstract

Given the multiple stressors facing the marine environment, and shallow reef systems especially, research to protect biodiversity of the oceans is crucial. Artificial reefs have been deployed around the world for many purposes including habitat restoration, coastal protection, fisheries enhancement and recreation.

Interreg Atlantic 3DPARE project has produced 3D Printed artificial reef units which include a variety of habitats suitable for marine life including holes, tunnels and overhangs of varying size and depth. The 3D printed reefs were installed at four sites across the North Atlantic Region in Spring/ Summer 2020. We used SCUBA and Remote Underwater Video (RUV) to characterise the communities associated with the 3DPARE reef units and adjacent natural and artificial habitats.

After 6 months the reef units had significantly increased the biodiversity of the sites and there were clear differences between habitat features. Differences were also observed between sampling methods. This highlights the importance of a combined method approach to surveying subtidal habitats. Data obtained through video surveys is also an extremely useful tool for public engagement.

Future monitoring will focus on the specific AR unit features and how they attract marine life, and help maximise native flora and fauna assemblages. This pilot study will help inform the design of future subtidal infrastructure in order to create multifunctional structures with suitable habitat for marine life.

Keywords

reef systems, artificial reefs, ecology, survey techniques

O20.2

Marineff project: scaling-up eco-engineering trials on artificial coastal structures

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Abstract

Intertidal habitat is declining due to multiple stressors, including sea level rise and the proliferation of artificial coastal structures (ACSs). Socio-economic and recreational pressures on developed coastlines add to the urgency that necessitates designing coastal infrastructure that better facilitates habitat. Most ACSs involve hard engineering that has low complexity and smooth textures which do not provide adequate habitat analogous to natural rocky shores. Recent research has demonstrated that enhancing ACSs with habitat features, such as cracks, crevices and areas of water retention, increases biodiversity. These studies are predominantly small-scale and short-term and so larger-scale, longer-term studies are required to demonstrate the efficacy of these features for coastal practitioners. This is essential to permit acceptance and application of eco-engineering within real-world engineering.

The Marineff project, co-funded by the European Regional Development Fund, has installed one of the largest arrays of artificial rockpools to date. Spanning two sites on the south coast of England and involving 90 concrete artificial rockpools, we investigate how to maximise biodiversity benefits by arranging the rockpools as single units or as horizontal groups of 3 or 5 rockpools. Over 2 years, we will be monitoring changes in species richness and abundance in the following habitats: the interior and exterior of the pools, the surrounding seawall above and below the pools, in unenhanced control sections of the seawall, and a separate, unenhanced control 80m section of seawall.

Here we present initial results following 1 year of monitoring. Benefits are apparent at the scale of tidal level, seawall section and seawall extent, however the magnitude of enhancement is dependent on site. Compared to control sections, the artificial rockpool sections have overall greater species richness. The rockpool interiors host species not found on the seawall and rockpool specialists such as Montagu's blenny *Coryphoblennius galerita.*

Keywords

eco-engineering, ecological enhancement, coastal engineering, marine ecology

O20.3

Utility of models in setting restoration objectives

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Abstract

Estuaries are both naturally complex and human-impacted environments where restoration initiatives may suffer from the lack of ecological knowledge and methods to set restoration objectives. Despite a growing number of published case-studies, it remains difficult to establish a clear link between ecological benefits following restoration operations and pragmatic restoration actions. In France, the French Office for Biodiversity (OFB) and the French Geological Survey (BRGM) developed a framework for ecological restoration in estuaries to promote and implement actions. Relying on the need to consider not only structures but also processes, this framework leads to the necessity to set measurable and achievable restoration goals at the relevant spatial scale (taking into account the physico-chemical estuarine gradients). Interviews with managers identified the difficulties in programming restoration operations and a need for in-depth analysis of restoration experiences with respect to the conceptual framework and available decision support tools. The work offers in particular a structured consideration of the use of modelling tools given the damaged or lost ecological functions. Their use and limits are discussed in the context of different estuarine functioning (hydromorphosedimentary, biogeochemical and as a support for different species life cycle), acquired and missing knowledge, data and skills requirements.

Keywords

modelling, objectives, restoration actions, ecological functionning

O20.4

Classification of estuarine states in temporarily open-closed estuaries using network analysis.

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Abstract

Temporarily open-closed estuaries are driven by the natural seasonal cycle of rainfall and associated catchment flows. Because of the variability of catchment flow intensity and volume, the ecosystem water quality parameters and associated states fluctuate broadly. These states may be exacerbated or dampened by development-associated pressures in catchments, which can alter the food-web dynamics in the estuary. Despite this, the association between food-web dynamics and physical state remains unquantified for most South African estuaries. This study addresses this issue by linking physical ecosystem state to food-web functioning in an impacted case study system. Empirical food-web networks were built and solved across seventeen time steps using a Linear Inverse Modelling (LIM) approach, and specific Ecological Network Analysis (ENA) metrics were obtained for each. Time steps were assigned to either a “Poor” or “Fair” state using an existing water quality framework. An approach comprising classification trees and random forest models yielded the suite of ENA metrics which best predicted which state the ecosystem was in, thereby depicting how important functional parameters are linked to ecosystem state. While many of the investigated ENA metrics could effectively classify the ecosystem states, a combination of just two was required to attain an interpretable and accurate classification: flow diversity and the ratio of detritivory to herbivory. The most common interactions between ENA metrics outlined how different scenarios of energy flow in the food-webs were linked to ecosystem state. These comprised of flow diversity, ratio of detritivory to herbivory, average path length and average trophic level. For generalization to other systems, optimization of LIM model solutions and inclusion of data from additional systems are needed. Nevertheless, the distinction between poor and fair water quality was effectively described by system-level ENA metrics, highlighting the role of physical conditions in influencing estuarine ecosystem dynamics.

Keywords

Estuaries, Ecological Network Analysis, Food-webs, Ecosystem Modelling

O20.5

Human-mediated changes in invertebrate community structure for the KwaZulu-Natal coast: large scale temporal and spatial analysis.

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Abstract

Freshwater flow plays a vital role in determining estuarine health and characteristics and may be influenced by climate variability (precipitation and evaporation). Variability in freshwater flow determines the key features of the estuary, such as the salinity gradient, sediment characteristics and others. These changes to freshwater input can also affect habitats and organisms within estuaries, and this study aims to investigate the sensitivity of zooplankton, macrozoobenthos and meiofauna to changes in water chemistry in the temporarily open estuary systems (TOCEs) in the KwaZulu-Natal Coast. A suite of environmental variables was assessed to find the combination of variables that best explained patterns of biota community composition, using data spanning several decades. Together, these provided a wide range of environmental conditions. Of these, variables with the largest influence on the invertebrate communities, as well as single species, were used to find direct effects through multiple regression and multivariate analysis. The results indicated how invertebrate species respond differently to the various environmental variables, and as such contribute to the resilience of the community as a whole. This study contributes to our understanding of predicting potential community responses to global change.

Keywords

climate variability, invertebrates, resilience, estuarine health

O21.1

Spatio-temporal trends in marine debris across Australia: 10 years of beach clean-ups

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Abstract

Anthropogenic marine debris (AMD) is now a permanent component of oceans, contributing risks to ecosystems and the coastal communities they support. Whilst knowledge of debris fluxes is steadily advancing, there is incomparable and limited debris monitoring at different spatial and temporal scales. Citizen science (CS) addresses this shortcoming, in allowing sampling at a greater spatio-temporal resolution than otherwise possible. Further, involvement of communities with environmental issues has the potential to drive behavioural change. However, CS projects are critiqued for data accuracy and potential biases between collecting groups. Here we present a 10-year analysis (2009 to 2018 inclusive) of trends in marine debris across Australia, using data from the Australian Marine Debris Initiative (AMDI). The database contains entries from over 17000 events, from over 3600 sites, contributed by 2400 unique groups. Through differences in filtering criteria and intensity, we demonstrate the need for filtering to discern overall trends. We further provide a preliminary assessment of sampling biases between clean-up groups (*e.g.* school groups, NGOs, businesses) and identify items that may be under or over-reported. Our study demonstrates the value of CS datasets performed with a common and rigorous methodology, intensive filtering and identifying biases within the data. This study forms the foundation in understanding environmental and human factors that control debris flux and the development of source reduction plans across the Australian coast.

Keywords

Citizen Science, Environmental monitoring, Plastic pollution, Spatial analyses

O21.2

Utilization of oyster shells to improve coastal benthic pollution in Tongyeong, Korea

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Abstract

This paper aims to evaluate the effect of oyster shells on improving the benthic environment in coastal sea through field experiments. In June 2020, 4 tons of oyster shells were covered on the sediment with area of 100 m^2 in Tongyeong, Republic of Korea. And seasonal monitoring was carried out. The main results obtained from the monitoring can be summarized as follows. In the sediment samples covered with oyster shells, the concentrations of PO_4-P and NH_3-N decreased by up to 38% and 27%, respectively. In addition, metagenomic analysis results shows the number of anaerobic bacteria decreased in oyster shells covering sediment. From the above results, covering of oyster shells can improve coastal pollution and may contribute to promoting the recycling of fishery waste and reducing costs for remediation of polluted coastal sediment.

Keywords

Coastal Benthic Pollution, Oyster Shells, Nutrients, Metagenomic analysis

O21.3

Feasibility of DOM used as fingerprint in coastal pollution accident source identification

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Abstract

Dissolved organic matter (DOM) plays an important role in migration and transformation as well as microbial degradation of pollutants in aquatic systems. However, there is few data using DOM as a fingerprint source identification method in coastal pollution accident. In this study, absorption spectroscopy, optical indices, three-dimensional fluorescence excitation-emission matrix (3D-EEM) and parallel factor analysis (PARAFAC) as well as principal component analysis (PCA) were used to trace the source identification in coastal pollution accident. The remote sensing image, estuarine diffusion model and component analysis of potential industrial wastewater were applied to test and verify its feasibility. Marine water and sediment samples in offshore polluted area were analyzed synchronously. The results indicated that the DOM in polluted area (an estuary bay) from terrestrial source contribution were high aromaticity and molecular weight materials. Four components of humic (C1 and C3) and protein-like components (C2 and C4) were identified by PARAFAC model. PCA results revealed that C1, C2 and C3 exhibited same trends and were directly related to wastewater discharge from potential enterprises. While C4 was significantly autochthonous (authigenic) by the activities of microbes after long-distance anaerobic transport of pollutants from industry. Affected by the discharge of mixed wastewater sources with high fluorescence index (5.81), more protein-like components (56%) and high biological index (1.87) were observed in marine water in polluted area. However, most humic-like components (62%) with high humification degree (3.69) were found in surface sediments. These indexes indicated that the DOM in the estuary was homologous with industrial wastewater. Remote sensing image (black strip), results of diffusion model and comparison of fluorescence characteristics with industrial wastewater also confirmed that DOM can be used as feasible fingerprint method to trace pollution source in coastal pollution accident.

Keywords

DOM, 3D-EEM, Source identification, Pollution accident

O21.4

Modelling the marine coastal zone using a well-fed ecohydrodynamic model

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Abstract

We present the capabilities and results obtained with one of the WaterPUCK online toolkit's products. WaterPUCK is an innovative and complex toolkit that enables researchers to identify the sources of nutrient and pesticide pollution, understand the main mechanisms responsible for the transport of these pollutants in surface and groundwater, calculate their flux via rivers and SGD, and directly assess the influence of pesticides and nutrient flux on the Bay of Puck (southern Baltic Sea) ecosystem, including the creation of scenarios projecting the effects of changes in land use on chemical loads from the Puck Commune that are transported via surface and groundwater to the Bay of Puck. One of the models that the toolkit consists of is the ecohydrodynamic model of the Bay of Puck, named the EcoPuckBay (EPB), which is discussed in this presentation. It is crucial that the biochemical part of the EPB model is fed with inputs from the SWAT surface run-off model and Modflow groundwater flow model which are also coupled with each other. As part of the EPB model, we developed a tool named the Nutrient spread module (NSM). With the NSM it is possible to model the expected distribution of agricultural substances in the waters of the bay in a short period of time (10 days), which can be helpful when extreme events occur and in making decisions to mitigate the negative effects associated with them. Solutions that comprehensively connect the marine and land environment are essential for resources monitoring and management especially in the coastal zone which plays a beneficial role for humans.

This work was supported by the National Centre for Research and Development of Poland within the BIOSTRATEG III program No: BIOSTRATEG3/343927/3/NCBR/2017.

Keywords

numerical modelling, ecosystem, biogeochemical model, nutrients

O21.5

Tracing source and mobility of major, trace and rare-earth elements in a tropical estuary: A multivariate approach

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Abstract

In this work, a multivariate approach was applied to determine the multi-element signatures of surface water, suspended particulate matter (SPM) and sediments in the tropical Cai River estuary under multiple stresses.

The bulk element content, enrichment factor (EF) and partition coefficients between filtered, particulate and sedimentary phases were determined and linked to the major environmental factors by the application of Principal Component Analysis (PCA) and Redundancy Analysis (RDA) to the data obtained. Most of the major, trace and rare-earth elements studied are introduced in the Cai River and its estuary by basement rock weathering under enhanced monsoonal precipitation. These elements show low chemical mobility and mainly settle within the downstream sedimentary phase due to the association with terrigenous aluminosilicate clay host minerals. Co, Ni, Cu, As and Mo were mainly accumulated within both the upstream and downstream particulate phases, showing high chemical mobility due to their association with the most labile fraction of the fluvial particulate load (mainly organic colloids and carbonates). Overall, Bi showed both severe enrichment and a nonweathering distribution pattern in the solid phases with respect to other elements considered.

The major factor controlling element distribution between filtered and particulate phases is the salinity gradient and associated total suspended sediment (TSS) removal from the water column accompanied by a release of particulate elements into the solution. The major factor controlling element distribution between particulate and sedimentary phases is the salinity gradient and associated nonorganic colloid dynamics.

Further studies should focus on the colloid pool composition and dynamics.

Keywords

Nha Trang Bay, tropical estuary, salinity gradient, element partitioning

O21.6

Platinum variability in a hydrodynamic estuary: Effects of contrasting environments and fate

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Abstract

Platinum (Pt) is one of the less-studied elements in estuarine waters. Consequently, understanding its speciation analysis and environmental fate remains limited regardless of its emerging environmental concern. This study addressed the occurrence and discrimination of soluble/insoluble Pt species in a hydrodynamic aquatic system and their potential transport was evaluated. Particulate (Pt_P) and dissolved (Pt_D, <0.45 μm) forms of platinum were determined in the water column of the Tagus estuary. Two contrasting environments encompassing different salinities and sources were sampled during semi-diurnal tidal cycles, neap (NT) and spring (ST) tide. The two stations were located in the upper Tagus estuary (VFX) and near the mouth, close to a wastewater treatment plant (ALC). Pt was analyzed by voltammetry and ICP-MS, and ancillary parameters were determined. The concentrations of Pt were higher during the low tide, following the tidal regime. Those ranged between 1.0–25.6 ng g^{-1} and 0.1–11.7 ng L^{-1} for Pt_P and Pt_D, respectively. The Pt levels found at the WWTP outfall were higher than upstream, mirroring anthropogenic inputs from automotive catalytic converters and an additional Pt source originated in Pt-based compounds. Distribution coefficients (K_D) of 10^4 were computed and were independent of the salinity gradient. During the NT, the speciation analysis done at VFX showed that truly dissolved forms measured by voltammetry represented 39±9% of total Pt in the water column. In contrast, total filter-passing species measured by ICP-MS were higher, 65±14%. These results suggest that dissolved forms control Pt speciation in the estuarine water column. The potential transport evaluated at ALC indicated recirculation within the estuary and export towards the coastal area, with higher concentrations throughout the ebb opposing to the flood. This study highlights the estuaries as important pathways to introduce Pt in coastal regions, transferring them towards the ocean.

Keywords

Platinum, Particle-water interactions, Speciation analysis, Environmental fate

O21.7

Land-based sources of microplastics in the Lis River, Portugal

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Abstract

Through time, plastic has improved our daily chores, medical supply, entertainment, etc. It seemed the perfect product however, nobody thought how to dispose of this long-lasting product and its consequences. Nowadays we struggle with plastic pollution in the ocean, a worldwide known problem that is damaging the Ecosystem, impacting the climate, our resources, and life itself.

Plastic has 2 main problems, toxic chemicals associated to production, and its constant degradation, leading to microplastic. Particles from land-based sources are transported through rivers to the sea and depending on their density can sink or drift, becoming available for ingestion by pelagic or benthic organisms. These particles can be transported amongst the food web and reach humans through diet.

Thus it´s important to evaluate the sources and transportation by rivers to implement strategies to prevent and reduce.

The Lis river has more than 100 industries alongside its 37km, including plastic producers, sellers and recyclers, waste management companies, and wastewater treatment plants. Considering this location, 8 sampling sites were analyzed regarding the composition, distribution, and abundance of microplastic. Water and sediment samples were collected seasonally.

Plastic types found were fibers, filaments, pellets, fragments, films, foams and microbeads. Fibers were the most abundant type alongside the river and throughout the year. The amount of microplastic transported from the river to the sea varied with season as their polymer composition.

This work is part of a larger project where models will be implemented to describe the paths of microplastic and identify accumulation hotspots. A collaborative process will be developed in the co-construction of strategies to mitigate plastic pollution involving stakeholders in the watershed. Collection of accumulated litter from hotspots may potentially interest recyclers and means more plastic will be available for recycling, thus removing larger quantities from the ecosystem towards a circular economy.

Keywords

Microplastic, River transportation, Strategies, Mitigation

O22.1

Upscaling small-scale spatial and temporal changes in microphytobenthos biomass for large-scale primary production estimates

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Abstract

Estuaries are productive and highly diverse ecosystems. Primary production of microphytobenthos (MPB), microalgae that form dense biofilms in the top layers of intertidal sediments, contributes greatly to this productivity and as such, sustains whole coastal food webs.

Surprisingly, relatively little is known about the magnitude of microphytobenthos productivity at the ecosystem scale. This is mainly due to difficulties in monitoring MPB in dynamic and often inaccessible tidal environments. The last decades, remote sensing has emerged as an important tool for upscaling field biomass measurements, with the Normalized Differential Vegetation Index (NDVI) commonly used as a proxy of MPB biomass. However, linking images to primary production remains challenging.

Modeling MPB productivity from surface biomass requires precise knowledge about the vertical distribution of the MPB in the upper, illuminated layers of the sediment (photic zone). This vertical distribution can vary greatly between MPB communities and sediment types. To date however, information about the vertical biomass distribution cannot be obtained from remote sensing images.

We aim to develop a calculation tool incorporating the vertical biomass distribution of different MPB communities into benthic primary production estimations. To this end, we developed a novel, rapid, high-resolution measuring technique based on hyperspectral imaging to visualize both the top surface and the vertical NDVI profiles of MPB biofilm in intertidal sediment. The technique was used to study vertical profiles of two MPB communities in the Scheldt estuary: one euglenid dominated and one diatom dominated biofilm. The results were then implemented in a primary production model to study the effect of differences in vertical profiles on primary production estimates.

Using hyperspectral imaging enables resolving MPB biomass distribution much more rapidly than currently used techniques based on core sectioning and pigment analyses. Furthermore, model simulation show that differences in vertical biomass profile can greatly influence MPB primary production.

Keywords

Primary production, Microphytobenthos, Remote sensing, Modelling

O22.2

Temporal and spatial variability of physico-chemical and biological components of the Sado Estuary (Portugal)

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Abstract

Estuarine zones are very productive areas that receive great interest from local communities. While regional socio-economic development is a priority for most managers, estuaries are prone to conflicts that sometimes are hard to handle. Hence, sustainable development, that considers the implementation of sustainable aquaculture practices, has to be based on the preservation of the ecosystem, ensuring the maintenance of habitats, biological components as well as their function and interaction. For this, it is important to understand how environmental and biological conditions vary over time and space and how they interact with the use of the system. The objective of this study is to evaluate the environmental quality of the Sado Estuary, in an integrative perspective, at the ecosystem-scale, promoting the use of the natural element, estuarine microalgae, as a food source in the sustainable production of bivalves, namely the Portuguese oyster (*Crassostrea angulata*) and other species with potential for production. To meet this goal, the estuary was sampled monthly during 2018-2020, regarding physico-chemical (temperature, salinity, oxygen, nutrients) and biological parameters (phytoplankton biomass and species composition, microscopy and HPLC), as well as metals and contaminants. Historical data, from 1986 to 2010, were also gathered. A preliminary analysis revealed the existence of an upstream-downstream gradient for most parameters (temperature, salinity, dissolved oxygen, suspended solids, nutrients and chlorophylls). Nutrient levels were seen to be the highest during winter and the highest values of chlorophyll *a* concentrations were observed in spring/summer, with downstream (near river mouth) peaks in April and upstream peaks in June. Generally, the levels of nutrients and chlorophyll *a* concentrations are within the standard levels for the most Portuguese estuaries. However, in 2018, results revealed a 1-month delay in the phytoplankton bloom occurrence, which may have direct implications for the higher trophic levels.

O22.3

A meta-analysis on knowledge of estuarine fish communities and fisheries from the West coast of India

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Abstract

Considering variability in salinity of estuarine waters caused by Indian summer monsoon, Indian estuaries are often called monsoonal estuaries which comprise an area of 1.44 million ha of which west coast estuaries accounts an area of 6.49 lakh ha. Documentation on fishery resources of estuaries of India were begun in late 18th century. This paper aims to generate an up to date knowledge on fish communities and ecology of estuaries of the west coast of India (WCI) and to find out the potential scope for further research and development. Data from literature were collected including published journals, articles, periodicals, and research papers. West coast is divided into three regions namely Konkan – the northern part that includes Gujarat & Maharashtra, central part includes Goa and the southern stretch that extends from Karnataka to Kayakumari. Indian west coast is bestowed with more than 60 estuaries and among explored, Vembanad (200 km$^{2)}$ with 122 finfish is the largest and Poovar (0.3km$^{2)}$ is with 28 finfish the smallest estuary(based on area). Average yield of estuarine fish in India varied between 45 and 75 kg ha^{-1}.Fishing gears used includes a variety of types including gillnet,castnet,stakenet,hook and line and traps. The most important fish species exploited were *Mugil cephalus Chanos chanos, Etroplus surentensis, Lates calcarifer, Ambasis ambasis, Silago sihama, Tenualosa ilisha, Gerres filamentosus,* and *Escualosa thoracata.* Some of the estuaries are subjected to anthropogenic stressors such as sewage waste disposal, industrial effluents, illegal fishing, and construction of dams. Studies in various dimensions of fisheries such as taxonomy, biology, ecology, diversity and distribution, climate change impacts, and socio-economic profiling were also discussed. Suggestions and recommendations for the conservation and management of WCI estuaries are also deliberated

Keywords

Indian west coast estuaries, Estuarine fishes, Anthropogenic stressors, Recommendations

O22.4

Long term assessment of Red sea heat waves and the associated thermal stresses on the rich coral reefs spots

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Abstract

Coral reefs are experiencing increasing impacts of climate change through heatwave events resulting in mass coral bleaching being widely reported. The optimum aim of the current paper is to study the heat waves over the Red Sea using 0.25 daily gridded Optimum Interpolation Sea Surface Temperature (OISST) data from 1982 to 2020. The Red Sea was divided into 16 clusters according to warming characteristics. The analysis indicated that the Red Sea experiences heatwave events, most pronounced over the Gulf of Aqaba where the most marked heatwave event lasts for 18 days between 29 July 2012 to 15 August 2012. Moreover, twelve sites of rich coral reefs in Egypt and Saudi Arabia were assessed based on the long-term thermal stress by the calculations of Thermal stress anomalies and Degree Heating Weeks (DHW) indices. The bleaching threshold limit varies between 27° degree Celsius in the northern parts to 32° degree Celsius in the western and southern parts. The long-term analysis of the different locations confirmed that the frequency of the elongated thermal stress periods increases in the last decade if compared with the last four decades. Although it is widely believed that the bleaching events are concentrated on the western and southern parts of the Red Sea, the Northern parts experienced high levels of thermal stresses without confirmed reports of mass bleaching. The study represents a good database for studying the resilience of the Red Sea coral reefs and confirms the inevitable need of studying the local hydrodynamic characteristics of each location.

Keywords

Red Sea , Heat Waves , Coral Reefs , Bleaching

O22.5

Baited remote underwater video survey of winter fish communities in Keret Archipelago, the White Sea

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Abstract

Understanding of winter state of Subarctic and Arctic marine communities is crucial, as shifts in high-latitude ecosystem functioning occur faster than in temperate regions due to the ongoing climate change. The White Sea is covered with sea ice during winters and thus while data from summer monitoring studies of marine species are widely available, winter state of either benthic or fish fauna is limited. In mid-March 2021, we used the baited remote underwater video (BRUV) system to evaluate the depth distribution of species in combination with the 24h gillnet survey. The 1.5-hour video deployments were implemented across five sites within the 6 sq. km. area of Keret Archipelago at a depth ranging between 5 to 58 meters (more than 20h of exposure). The bait consisted of a mixture of cat food, rice and pelleted poultry feed placed in soft net bags. In total, we recorded eleven fish species, three of which (*Myoxocephalus scorpius, Gymnocanthus tricuspis and Limanda limanda)* were observed using both techniques, six (*Amblyraija radiata*, *Clupea pallassii*, *Eleginus nawaga*, *Gadus morhua*, *Lycodes pallidus*, *Triglops murrayi)* were only caught in the gillnets and two (*Platichthys flesus* and *Lumpenus fabricii)* were observed using BRUV system only. Highest fish diversity was observed at 40-meter depth where water temperature approached maximum (+1.5^{o}C), and decreased in either shallow nearshore sites or deep sites align with decreasing water temperature. The bait also attracted amphipods *Anonyx nugax* and *Halirages fulvocintus*, sea stars *Urasterias lincki,* whelks *Buccinum undatum* and hermit crabs *Pagurus pubescens*. *L. limanda and P. flesus* were probably attracted by both bait and amphipods, while *L. fabricii* as well as shrimps *Pandalus sp.* and *Sclerocrangon boreas* were attracted by camera light. Our data demonstrate that BRUVs may provide substantial information for monitoring fish communities under the ice. The study was supported by RSF grant 19-14-00092.

Keywords

BRUV, under-ice fish communities, Subarctic, The White Sea

O22.6

Pulse eutrophication of Academy Bay, Sea of Okhotsk by killed salmon

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Abstract

Academy Bay is estuarine wild area on the north-western shelf in Sea of Okhotsk and is a part of aquatic are of Shantar Archipelago. This is an important feeding ground Bowhead whales (Balaena mysticetus) during late summer – autumn period. Two hydrochemical surveys were implemented in July 2016 and September 2020, respectively. Our hydrochemical data of the bay including Syran and Ulban Rivers suggest that this is oligotrophic basin which unable to provide food for Bowhead whales in July 2016. However our data obtained in September 2020 suggest that this is highly productive heterotrophic area which can provides enough plankton biomass as food for polar whales. We hypothesize that salmon coming in Academy Bay in July after spawning can be source of nutrients and organic matter for planktonic community and polar whales as well.

This study was partly financially supported by Russian Foundation Basic Research RFBR, Russian Academy of Science (grant #21-55-53015) and scientific themes of POI FEB RAS (#*121021700346-7*, #*121-21500052-9*)

Keywords

eutrophication, nutrients, Bowhead whales, Academy Bay

O22.7

The development of an environmental DNA method to assess estuarine fish biodiversity

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Abstract

The ecological quality of estuaries is assessed in the United Kingdom under the Water Framework Directive by monitoring key ecological groups, including fish. Fish surveys currently use seine and fyke nets, and beam trawls. Comparably, Environmental DNA (eDNA) metabarcoding may be a non-invasive, cost-effective, complementary method. However, its application to fishes in estuaries is understudied. We present a comprehensive assessment of the effectiveness of eDNA metabarcoding to survey estuarine fish biodiversity at multiple spatial and temporal scales. Firstly, we investigated the ability of eDNA to detect a spatial transition from a freshwater to marine fish assemblage across seasons. Triplicate water samples were taken at stations along a transect on the Dee estuary, during October 2018 (15 stations) alongside netting methods, and in June 2019 (11 stations). Secondly, we assessed short-term tidal variability in fish assemblage eDNA. Duplicate samples were taken at one station on the Conwy at high and low tide over 15 days (30 events) covering a spring to neap tide in Autumn 2020. Thirdly, we investigated variation in assemblage composition from eDNA between three estuaries, across seasons, alongside netting methods. Triplicate samples were taken along transects in the Esk (4 stations), Tweed (3-4 stations) and Tees (2 stations) in spring and autumn 2017, and autumn 2016 for the Esk and Tees. Water samples were filtered, eDNA extracted and metabarcoding conducted using 12S rRNA with Illumina® sequencing. Results will be presented with reference to contemporary and historical netting data. Preliminary analysis from the third, inter-estuarine, study suggests eDNA detects twice as many species as netting, including species of conservation interest e.g. European river lamprey. In addition, it maybe that eDNA captures spatial and temporal variation more effectively than netting methods. We therefore present emerging evidence that eDNA is an effective method of assessing the biodiversity of fishes in estuaries.

Keywords

Environmental DNA, Biomonitoring, Fishes, Water Framework Directive

O23.1

Hydro-sedimentary dynamics in the Vietnamese Mekong Delta: monitoring and field surveys

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Abstract

The flow and sediment fluxes of the Mekong River are of crucial importance to sustain the Vietnamese Mekong Delta (VMD), supporting the delta surviving from natural and anthropogenic erosion processes. However, a full understanding of the hydro-sedimentary dynamics of the entire delta is limited because of sparsely temporal-spatial monitoring stations installed under the Mekong River Commission framework. Therefore, we conducted two campaigns in February 2016 and in February 2017 to install additional three stations to monitor turbidity, and two field surveys in August-September 2017 and in March-April 2018 to measure the velocity, discharge, turbidity, and river cross-sections of the entire Tien and Hau rivers (two main rivers) in the VMD. Main results of the study are as follows.

The Tien and Hau rivers are distinguished into two reaches. The division locations are changeable in between Cao Lanh and My Thuan (in the Tien river) and in between Long Xuyen and Can Tho (in the Hau river), depending on the seasons. The upper reach is dominated by the fluvial processes, and the lower reach is dominated by tidal processes.

In the upper reach, the rivers are narrow, sinuous, and deep. Riverbed elevations and turbidity decrease seaward. River cross-sections, flow velocities, and turbidity are asymmetric. In the lower reach, the rivers are wide, straight, and shallow. Riverbed elevations and turbidity increase seaward. River cross-sections, flow velocities, and turbidity are symmetric.

Turbidity maxima occurs during the low-flow season due to the saline water cycle. Mid-river islands commonly appear within the last 35 km from the river mouths.

Turbidity measured at our installed monitoring stations using automatic instrument is greater than that measured by the Mekong River Commission using manual instrument. Therefore, we recommend installing more monitoring stations in the VMD's rivers by using automatic, accurate, modern instruments with frequent recording.

Keywords

Turbidity, Hydro-sedimentary dynamics, Vietnamese Mekong Delta, Estuary

O23.2

Spatio-temporal patterns of particulate organic matter in coastal oceans

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Abstract

1. Introduction

A central aspect of coastal biogeochemistry is to determine how nutrients, lithogenic and organic matter are distributed and transformed. So far, organic components of TSM are determined from water samples, which limits spatio-temporal change analyses. Satellite images of surface Chla- and total suspended matter (TSM) concentrations indicate strong, time-variable linkages between intertidal fringes and offshore pelagic regions. We show how a linkage between sample data of total particulate organic matter (POM) and satellite TSM images adds valuable spatio-temporal information content.

2. Methods

We combined satellite images with sample data of TSM, POM, POC and PON from the North Sea using a specifically developed semi-empirical model. It separates refractory, mineral-associated from fresh, labile POM as a function of TSM by parameterising the net accumulation of fresh organic matter (Kpom) and the fraction of resuspended inorganic matter in POM (m_{POM}).

3. Results

Representative for all parameters in TSM dependence, POC:TSM sample data are high at low TSM, e.g. above 20 % in spring, and approach asymptotically a constant plateau around 2.5 % at large TSM (Figure 1). Model fits yield m_{pom} around 0.13 for all seasons. K_{POM} shows clear seasonal variations from 4.9 mg/l in spring, reflecting the phytoplankton blooms, to 2.2 mg/l in winter.

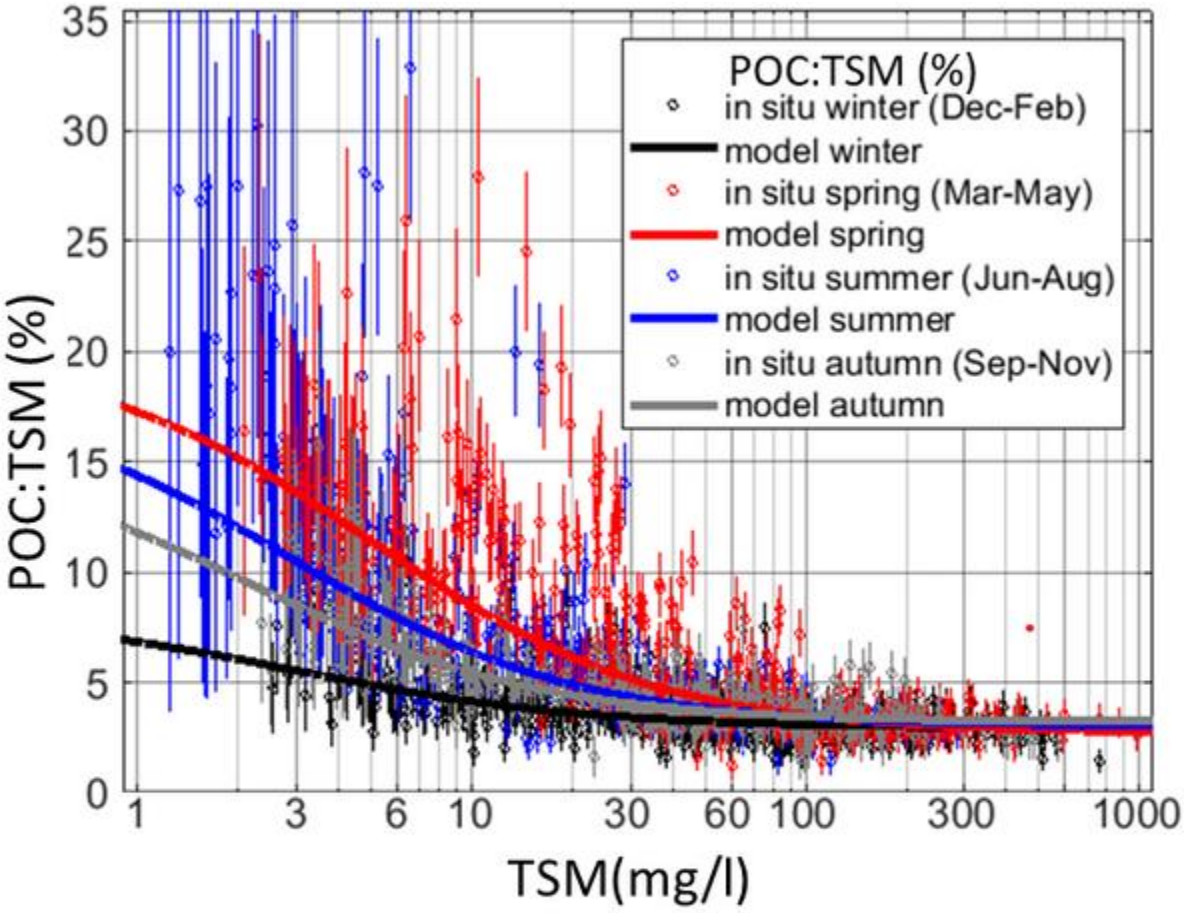

Figure 1: POC content (in %) as a function of TSM (Belgian North Sea, data from 2004 to 2020). Colours indicate seasons, curves show the model fits.

Figure 2 displays the difference between fresh and mineral associated POM for the spring in the German Bight. It shows a clear transition zone of equal parts of POM at water depths between 15 and 20m.

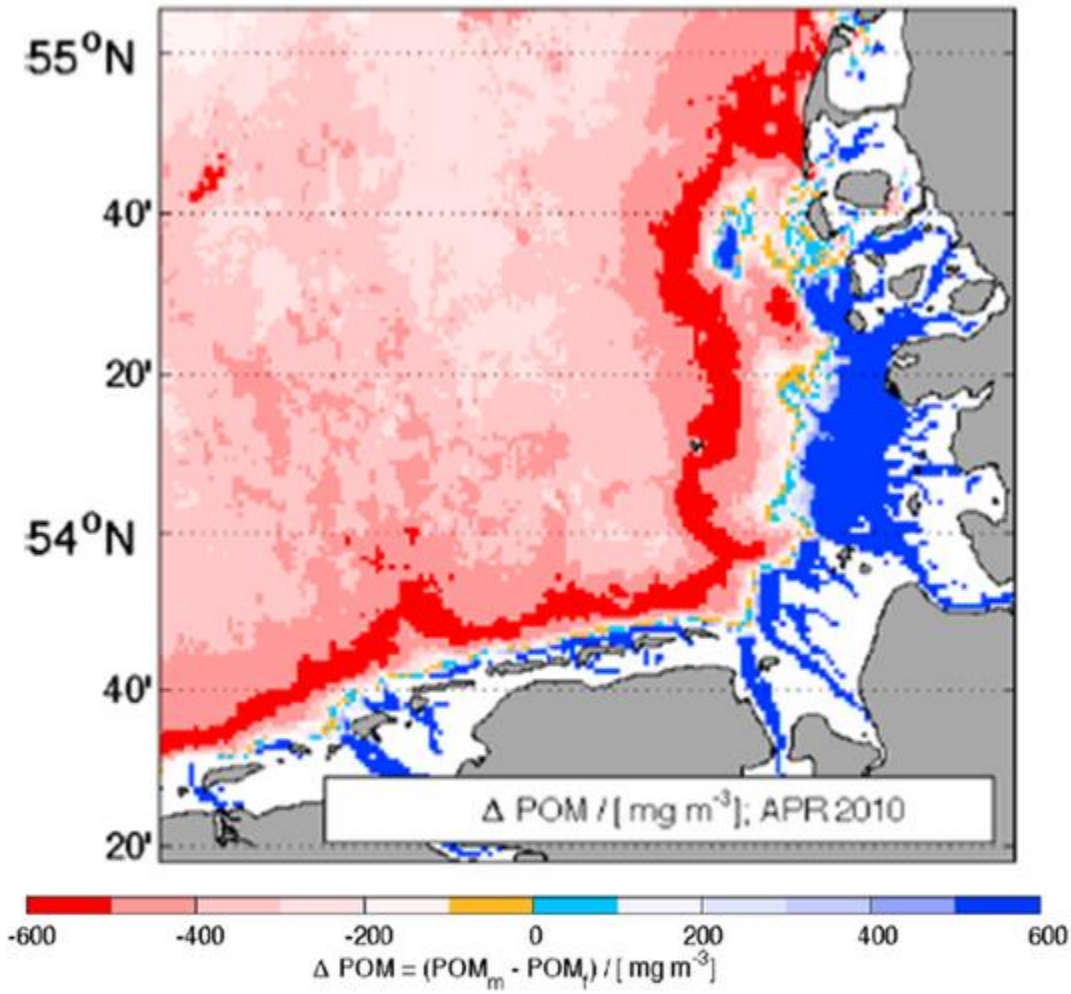

Figure 2: Satellite image of the difference between mineral associated and fresh POM. The POM values are computed by the pixel wise POM:TSM model application to the original TSM image (German Bight, April 2010; MERIS/ENVISAT).

4. Conclusions

The application of our model to satellite images of TSM yields spatio-temporal patterns of the build-up and decay of organic matter and the location of a transition zone between lithogenic and marine dominated suspended matter. When calibrated with samples this model can be applied satellite images or in-situ time series of TSM at any coast.

Keywords

Total suspended matter (TSM), Particulate organic matter (POM), Satellite Ocean Colour, Coastal biogeochemistry

O23.3

Multi-source data integration in assessing the Environmental Status of the Basque Coast (Bay of Biscay)

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Abstract

In the context of the Marine Strategy Framework Directive (MSFD 2008/56/EC), a multidisciplinary study was carried out, with researchers from different disciplines, bringing together solutions for management practitioners in the Basque coastal zone (SE part of the Bay of Biscay). This area was selected as case-study and divided into Marine Reporting Units (MRU), following the MSFD terminology, collating, and integrating information from coastal and offshore marine areas, from a variety of sources (i.e., *in-situ* long-term monitoring data, data coming from annual/triannual surveys, multibeam data, satellite data, open-source data, etc.). These data, from a period of 2010 to 2019, were used to assess the environmental status in a holistic way, by using NEAT (Nested Environmental status Assessment Tool). A total of 68 indicators were used, covering several ecosystem components: physico-chemistry of sediments and waters, phytoplankton, benthic fauna and flora, fish, birds, mammals, alien species, and litter. The analyses include spatial scenarios (weighting and no weighting by MRU), as well as filtering by different MSFD descriptors (i.e., biodiversity, alien species, eutrophication, sea floor integrity and contamination).

NEAT classified the Basque coast into good status, with no clear spatial gradient in the status. Most of the ecosystem components were classified in high and in good status, except mammals, birds (in territorial waters) and some commercial fish species (*Merluccius merluccius, Trachurus trachurus, Lepidorhombus whiffiagonis* and *Sardina pilchardus*) classified in poor and in bad status, depending on the species. The main human pressure, affecting the area is fish trawling. In addition, it is evident that the more indicators were used, the more representative is the assessment of the area. We show the ways to combine this wide range of complex information for the assessment of the health status and for the management of coastal and marine waters.

Keywords

environmental assessment, holistic approach, Nested Environmental status Assessment Tool, coastal and marine management

O23.4

COASTNET: Integrating Earth Observation and in-situ data for coastal management

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Abstract

The **Portuguese Coastal Monitoring Network** (CoastNet) is a research infrastructure (RI) included in the **Portuguese Roadmap of Research Infrastructures**, designed to improve the understanding of **Portuguese coastal ecosystems' functioning** through the development of a remote coastal monitoring system. CoastNet aims at monitoring important coastal ecosystems of the Portuguese coast, through relevant chemical, physical and biological parameters, collected remotely in near real-time. This monitoring network is implemented through: 1) the development of an historical and near real-time satellite data centre; 2) the deployment of a set of sensors, to collect environmental and biological *in-situ* data, at three estuaries (Mondego, Tagus and Mira), which are almost immediately transmitted to our data centre; (3) acoustic receivers arrays deployed to track aquatic fauna movements; and 4) the compilation of an historical *in-situ* dataset of biological and environmental parameters. CoastNet provides a better understanding of the functioning of Portuguese coastal systems through the analysis of their temporal and spatial variability. Gathering such scientific knowledge is expected to improve scientific production, promote socio-economic activities, such as fishing and aquaculture, as well as the conservation of endangered species. A variety of services will also be provided to a wide range of stakeholders. Additionally, the **Portuguese Coastal Monitoring Network** provides full and free access to the collected data sets to the scientific community, public administration and private companies, through the dedicated **Geoportal**, available at: **http://geoportal.coastnet.pt**. A case study based on the Tagus estuary, covering the water continuum from the coastal zone to the inner parts of the estuary, will be presented.

O23.5

Tracking coastal change by assimilating from data sources with different spatial and temporal scales

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Abstract

We present an innovative and novel data assimilation method of combining satellite data, hydrodynamic model (Delft3D) outputs and land-based radar data using machine learning and advanced statistical methods (Dynamic Mode Decomposition) to determine coastal change. To assimilate these data we use machine learning and statistical methods to detect "patterns" or "modes" in near- and far-field wave climate that are attributable to sub- and intertidal bathymetry and changes therein. We then combine the dominant modes into a low-order representation of the system, providing informed estimates of spatial resolutions and temporal scales where no measurements are physically performed. Satellite data and associated hydrodynamic model outputs are used to provide information on wave direction and height for the offshore-nearshore approaches while land-based marine radar located in the appropriate position provide wave data at higher temporal and more local spatial resolution.

The data nexus we present in this presentation demonstrates significant improvements in capability above and beyond the use of a given technology in isolation.

Keywords

Earth Observation, Radar Data, Modelling, Data Integration

O24.1

The ecological enhancement of coastal and marine structures by implementing bio-enhanced concrete elements into design

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Abstract

Coastal hardening replaces natural habitats with urban and industrial waterfronts that cannot provide ecosystem services similar to those offered by undisturbed coastlines. As a result, concrete based coastal and marine infrastructure are often considered as sacrificed zones ecologically with no environmental value.

The ecological engineering of shoreline schemes is an evolving discipline with the aim of building more inclusive, resilient, and safe coastal and marine structures for both people and nature that maximize benefits for ecosystems, society, and economies.

ECOncrete® offers sustainable solutions for coastal and marine infrastructure that provides fully constructive, cost-effective concrete products, with significant structural, biological, and environmental advantages. ECOncrete's technologies bridge the gap between sustainability and development with high-performance bio-enhancing concrete elements that significantly enhance the biodiversity, species richness, and live cover compared to standard "gray" concrete elements, without affecting the operational needs of the infrastructure.

Bio-enhancing concrete elements induce the growth of ecosystem engineers that have profound impacts on how communities develop; increasing species abundance and biodiversity. Species such as oysters, corals, and the like secrete CaCo3 skeletons onto the substrate serving multiple benefits. This "biological crust" serves as an active carbon sink as carbon is assimilated into the skeletons of these organisms. This form of bioprotection reduces the magnitude and frequency of structural maintenance, which translates into improved ecological stability (reduced anthropogenic intervention), and a higher ROI (reduced maintenance costs).

In an era of accelerated coastal development, we must promote innovative ways for developing more ecologically productive urban coastlines. Bio-enhancing concrete elements that are eco-engineered to support rich sessile communities serve multiple ecological, environmental, and operational goals. To achieve a significant ecological uplift in urban waterfronts, ports, and coastal protection there is a need for large-scale implementation, calling for practical solutions that can be simply and cost-effectively implemented into the conservative construction industry.

Keywords

ecological engineering, bioenhancement, coastal and marine infrastructure, carbon reduction

O24.2

Redefining wasted nutrients as a resource in coastal systems with aquaculture using national monitoring data

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Abstract

Increasing anthropogenic pressures on coastal systems mean it is vital to understand and forecast biogeochemical dynamics along the land-ocean continuum. In particular, where bivalve aquaculture is practiced, changes to local biogeochemical budgets such as nutrient enrichment can impact its economic viability, harming local communities.

Collecting the required physicochemical data to assess these biogeochemical dynamics over useful timescales can be challenging. However, abundant data exists in national governments' environmental monitoring programmes. By using this resource to construct mass balance models (MBM), we explore the likelihood of dissolved inorganic nitrogen (DIN) being exported from areas of restricted exchange to the open ocean, and estimate the magnitude of this flux in selected Irish coastal systems. Impacts of future changes in local biogeochemical budgets, caused for example by changes in the composition and magnitude of watershed inputs, can then be forecasted.

Here, we present our analysis of systems where aquaculture is a key economic activity. We quantify DIN that is exported to the open ocean and show how aquaculture yields could be increased using integrated multitrophic aquaculture. We discuss the usefulness of collecting extant data versus the creation of new data through dedicated field campaigns. We also evaluate the quality of the analysis by contrasting the outcomes of models created using extant data with those using new data created for that specific purpose.

Funded by Environmental Protection Agency Postgraduate Scholarship GOIPG/2016/1430, in strategic partnership with the Irish Research Council.

Keywords

Coastal biogeochemistry, Nutrient budget, Mass balance model, Bivalve aquaculture

O24.3

Using a bioenergetic model to address carbon sequestration of shellfish farming

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Abstract

Shellfish are increasingly been looked at as sustainable food sources that provide additional ecosystem services, such as water filtration and carbon sequestration. However, their role as CO2 sinks or sources is still highly debated: in order to quantify this, the shell accretion dynamics need to be taken into account. Bioenergetic models that investigate bivalve growth are mostly focused on the growth of the soft tissues, with the shell component usually calculated with allometric scaling relationships. Partitioning of energy into soft tissue and shell allows to investigate energy investment in relation to site specific environmental conditions. As part of this study, shell accretion was added as a state variable in a bioenergetic model of the Manilla clam (Ruditapes philippinarum). A keyparameter for energy allocation into shell growth was calibrated for four sites located in the Venice lagoon, where clams from the same cohort were monitored for one year during a transplant experiment. The model was then used to calculate CO2 fluxes resulting from respiration and shell calcification, taking in account CaCO3 stocked in the shell and CO2 emission. The function Ψ, that relates the amount of CO2released with respect to CaCO3 formed, was estimated usingenvironmental forcing functions (temperature, salinity, pH and alkalinity) observed in the proximity of each site. The findings show that the energy invested towards shell accretion varies slightly among sites and that clams play a role as a moderate sink of CO2 when the whole year is considered. Fluxes were characterized by a marked seasonal variability: due to respiration, clams were net sources of CO2 in wintertime, when growth slowed down. The model presented provides a useful framework for site selection in the context of balancing optimal food production and sustainability taking in account environmental variables, which can find a use coupled with climate forecasts.

Keywords

Carbon budget, Shellfish, Aquaculture

O24.4

Effects of offshore wind farms on the distribution of plaice (Pleuronectes platessa) in the Belgian part of the North Sea

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Abstract

Offshore wind farms (OWFs) are built at high speed in European waters to meet the EU 2050 renewable energy targets. The introduction of hard structures and scour protection layers in sandy environments, such as the Belgian part of the North Sea (BPNS), entails various opportunities for reef-associated fish and invertebrate species. For example, local attraction towards hard substrates and increased local production was found for pouting *Trisopterus luscus* and cod *Gadus morhua* in several OWFs, which was mainly attributed to an increased food availability. For flatfish species, which often prefer soft sediment habitats, our knowledge about their behaviour in relation to wind farms is still scarce. In this study we evaluated the presence of OWFs on the distribution of plaice *Pleuronectes platessa*, a commercially important species in the BPNS, at both large (OWF) and small (turbine) spatial scales. Large scale attraction to the wind farm was investigated by means of a BACI (Before/After-Control/Impact) design, using data collected with a shrimp beam trawl from within and outside two Belgian OWFs. A significant positive wind farm effect was found for C-Power, while no such effect was found for Belwind. The small-scale effect was studied by standardized visual diving censuses carried out close to the wind turbines in Belwind. Using Generalized Linear Models, we showed that the number of plaice was higher on the scour protection layer compared to the surrounding sand in between the turbines, implying an attraction effect of plaice towards the hard substrate around the turbine. Some preliminary telemetry results of tagged plaice individuals (age 2+) in the same OWF also indicate high residency and site fidelity during the summer period. As such, we could conclude that plaice can be attracted to OWFs both at a small and large spatial scale, although this effect differed between wind farms.

Keywords

Offshore wind farms, North Sea, flatfish, attraction

O25.1

Trace elements contamination and trophic transfer in Terra Nova Bay (Ross Sea, Antarctica): a baseline for monitoring environmental contamination and processes in the Ross Sea MPA

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Abstract

High contamination of trace elements (TEs) in coastal ecosystems and their transfer along food chains are pressing problems affecting even remote areas, like the Antarctic region. Here, we analysed Cd, Pb and Hg concentrations and carbon and nitrogen stable isotopes in organic matter sources and consumers from the Ross Sea i) to provide reference data prior to the recent institution of the Ross Sea Marine Protected Area and ii) to assess how food web features influence TE transfer along the food chain. Moreover, we made a special focus on top predators, by performing multi-tissues analysis of chick carcasses and eggs of Adélie and Emperor penguins, which are acknowledged bioindicators of environmental contamination.

Higher TE levels than those found in past studies were overall recorded in both abiotic and biotic samples, indicating increasing contamination in the Antarctic marine system in the last decades. Moreover, the higher TE levels found in penguin chick carcasses than in eggs suggested high toxicity risks also for scavengers. Regressions between log[TE] and $\delta^{13}C$ showed that the sympagic pathway drove Cd and Hg accumulation in secondary consumers, while a coupled benthic/pelagic pathway drove Pb transfer to all consumers. Regressions between log[TE] and $\delta^{15}N$ revealed that only Hg biomagnified along the food web, while the other TEs biodiluted, consistently with previous findings in temperate food webs.

Concluding, the present findings revealed a high baseline for TE contamination and represent useful reference data for the future monitoring of the Ross Sea MPA. On the other hand, they provide important insights about the role of basal sources in the transfer of non-essential TEs to the Antarctic biota, in the light of the forecasted trophic changes potentially resulting from variations in productivity and sea-ice dynamics due to climate change.

Keywords

Metal, stable isotopes, food web, penguin

O25.2

Factors affecting macrofaunal assemblages in the nearshore zone

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Abstract

Numerous studies have explored the ways in which certain characteristics of benthic macrofauna assemblages in sandy, nearshore marine environments are related to single physical variables. For example, how the number of species or densities of benthic macrofauna, sediment grain-size, depth, wave action, and organic content contrast and compare. Depth is usually correlated with a number of variables such as exposure to wave action, oxygen concentration or temperature. This study aims to investigate macroinfauna biodiversity patterns and their environmental drivers in False Bay, South Africa. Macroinfauna community patterns and their drivers are described from samples collected by van Veen grab sampler in three transects across the bay. Redox potential, sediment grain size and organic carbon were measured, and wave characteristics and slope were derived from an existing wave model and multi-beam data, respectively. Multivariate analyses revealed several communities related to wave energy, sediment grain size and depth. This research tests the Wave Exclusion Hypothesis and is the first to utilise modelled wave characteristics in such an analysis. Biological traits of observed species will also be related to environmental variables as a next step and the biological traits of the species identified will be explored.

Keywords

Nearshore, Wave Exclusion Hypothesis, Subtidal , softbottom

O25.3

Mercury budget and scenario analysis for the Venice Lagoon, using modelling and observations.

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Abstract

The Venice Lagoon was subjected to high Hg industrial in the 900's. Two modelling approaches were used to address the historical evolution of mercury (Hg) in the Lagoon and the high resolution dynamic in the present state. A box model based on EPA-WASP-MERC7 was implemented to reconstruct the temporal evolution of the total mercury (HgT) and methylmercury (MeHgT) concentrations in lagoon water and sediments over two centuries (1900–2100), from preindustrial to postindustrial phases. Moreover, a high resolution coupled hydrodynamic-mercury model based on SHYFEM and on the MERC code was implemented on a high resolution grid to better address the spatial variability and the effect of the seasonal and of the higher resolution forcings on the mercury cycle and fluxes. The two approaches allow to address the effect of physical and anthropogenic forcing on the mercury speciation and bioavailability in the Venice lagoon, and on the exchanges with the sea.

Keywords

mercury contamination, modelling, coupled hydrodynamic-chemical model

O25.4

Chemical anthropocene of the urban Thames estuary, London, UK: toward contiguous sedimentary records of pharmaceuticals, organo-tins, PCBs, PAHs, black carbon and toxicity

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Abstract

Shallow sediment cores of the Thames estuary provide an unparalleled record of London's historic anthropogenic chemical pollution (1930s to present day). However, changing diffuse and point source inputs, variable pollutant-sediment matrix partitioning as well as disposal and release lag dynamics can in some instances confound faithful representation. Black carbon, parent and alkylated polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), pharmaceuticals, xenoestrogens, faecal sterols/stanols, trace metal concentrations records reveal how recent chemical use and intentional and unintentional release maybe tracked from sewage input/treatment to changing fossil fuel use to rise in medicines and personal care products. Comparison with manufacturing and industrial records reveal improvements driven in part by environmental legislation and also by shifts in manufacturing, civil-engineering and power generation. Evaluation with complementary approaches such laboratory toxicity tests (microtox) reveal broader trends and processes influencing estuarine sediment quality. Comparison with other UK estuaries such as Clyde, Conwy, Mersey and Arthur Kill (Staten Island, New York, USA) reveal national and global similarities in chemical signatures.

Keywords

Estuary, Pollution, Chemical, Anthropocene

O25.5

Microplastic pollution on sandy beaches with different human-induced pressures from the European Atlantic coast (Portugal)

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Abstract

Microplastic pollution on sandy beaches is an issue of current concern due to their potential ecological and economic impacts. Yet our understanding of the levels of microplastics in these ecosystems and the drivers of these variations are still limited. In this study, the abundance and composition of microplastics were determined in four beaches with different degrees of urban pressure (industrial, urban, peri-urban and rural beaches) in the European Atlantic coast (Portugal). Beach sediments (5 replicates, 50 cm squares, along the drift-line) were collected in January, June and September 2016. Significant differences were found between the levels of microplastics between the beaches selected, with the maximum concentrations of 79 particles m^{-2}observed in the most urban beach, while the beach with lower levels was the rural beach (mean 10 particles m^{-2}). The particles were primarily fragments, pellets and fibres with varied colours. The chemical composition of selected particles was analysed using Fourier transform infrared spectroscopy (FTIR). A sub-sample revealed that the dominant plastic polymers were polyethylene, polypropylene and expanded polystyrene. We provide a baseline for future monitoring and discuss how urbanization of coastal areas can influence the levels of microplastics on sandy beaches.

Keywords

Sandy beaches, Plastic pollution, Microfibes, Urbanization

O25.6

Citizen science reveals microplastic hotspots within tidal estuaries and the remote Scilly Islands, United Kingdom.

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Abstract

The identification of microplastic hotspots is vital to our long-term understanding of their environmental fate and distribution. Although case studies have increased globally, sampling campaigns are often restricted geographically, with poor spatial resolution. Here, we use citizen science to increase our geographical reach, which improved our understanding of microplastic distribution in estuarine and beach sediment along the south-west coast of England. Sediment samples, collected by the Clean Seas Odyssey team, from estuaries near Plymouth, Fowey, Falmouth and two beaches on the Isles of Scilly off the Cornish coast were sent to the shore-based team at the University of Birmingham for microplastic analyses. Microplastics, between 63 and 5000 µm, were extracted using a Sediment Microplastic Isolation unit. The extracted supernatant was digested with hydrogen peroxide, stained with Nile red, and visualised using a stereomicroscope in fluorescence mode. Hotspots (> 700 particles per kg dry sediment) were identified on the Scilly Islands and in close proximity to major metropolitan hubs (i.e. Falmouth and Plymouth). Particles extracted from the Scilly Island sites were composed of polyethylene and polypropylene. With low population density on the Isle of Scilly, hotspots may suggest that microplastics originate from distant sources, while Falmouth and Plymouth, on mainland UK, are locally supplied. This information supports the design of future campaigns and targeted mitigation strategies in areas of highest concentrations.

Keywords

intertidal, accumulation zone, Nile red, English Channel

O25.7

Sediment contamination and pollution: Deterrence to mangrove restoration

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Abstract

The level and ecological impacts of heavy metal contamination and microplastic pollution in the sedimentary environments of mangrove systems in Guyana are poorly understood. This work investigates the distribution of and reports on the mass fractions of physicochemical properties of Mn, Fe, Co, Se, Mo, Ag, Sn, Sn, W, Bi, U and Le; and the lesser fractions of V, Ni, Cd, Hg, Pb, Bi and Th in sediment cores of the East Berbice-Corentyne mangrove restoration sites in Guyana. Their concentrations and enrichment factors were determined. The results show that these metals were mainly concentrated in the top 20 cm of mangrove sediment cores, then declined afterwards. This work further reports on the ecological risks posed by the contamination of these sediments to the survival of mangrove restoration project. The results of the different physicochemical properties indicate that the mangrove sediments are majorly contaminated by Mn, Fe, Cd, and Le concentrations and are of high ecological risks to the survival of replanted mangroves. Microplastic pollution, a common pollutant in marine and coastal ecosystems, is also observed as the pollutants challenging the growth of the replanted mangroves and a direct deterrent to restoration projects. Plastic particles in different sizes, shapes, colours and genera were identified from the sediment cores (0±30 cm depth) sampled from the study sites. The findings from this study have raised the concerns of contamination and pollution, which are principally from anthropogenic activities, as threats to the health of mangrove ecosystems and survival of mangrove replanting and restoration project. It is hoped that it provides insightful information for future management of and planning for mangrove sedimentary environment.

Keywords

Heavy metals, Mangrove sediments, Microplastics pollution, Ecological risk

O25.8

Review and update of Hg, Cd, and Pb in sediments and water of the inner estuary Estero Salado, Gulf of Guayaquil-Ecuador

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Abstract

The Gulf of Guayaquil (GG) is the most important estuary system of the eastern Pacific coast, it drains on average 1 654.5 m^3 s^{-1} fresh water. The main industrial city of Guayaquil (2.7 million inhabitants) lies in this basin and surrounds the inner estuary of the Estero Salado (ES). The ES has suffered from bad environmental management, it is definitely eutrophied, its fishery stocks dramatically diminished, and are affecting the Guayaquileño life. Potentially toxic metals such as Pb, Cd, and Hg in sediment and water have been sparsely studied, from 2010 to 2020. All average concentrations (as total, mg kg-1, dry weight) from 73 samples of water and sediments (and some fauna species) were: in water, 0.130, 0.038, and 0.0012; in sediments 42.97, 1.84 and 0.52; in fauna 13.01, 1.34 and <dl for Pb, Cd, and Hg respectively. Estuarine fauna was 13.01 and 1.34 for Pb and Cd respectively. All averages surpassed allowable National Regulation limits: 0.01, 0.005 and 0.0001; 35, 0.6, and 0.17 for water and sediments in the same order; and 0.3 (Pb) and 1.0 (Cd) for fauna. In 2020, results from a survey in the four most representative stations were: In sediments 41.93, 2.082, and 0.285, in the same order whilst in water all four stations had concentrations <dl. Also, Arsenic was also determined: 32.181 (sediments) and 0.007 (water). Maxima of 56.367, 6.079, and 0.158 and minima of 28.450, 0.285, and 0.078 were found. Compared to 2010-2018 averages, in the four stations Lead is not showing a statistical difference, Hg decreased 1.8 times, but Cadmium passed from 1.84 to 2.082. In the time series run, it was found a clear increase of Pb, while Cd and Hg seemed to decrease. There was not found any relationship between the studied elements. The estuary is badly contaminated by these metals.

Keywords

Estero Salado, Ecuador, Pb,Cd,Hg, Inner Estuary

O26.1

Patterns and potential environmental drivers of mesophotic communities of the warm temperate shelf of the Amathole Region, South Africa.

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Abstract

Foundational biodiversity research has seen a recent shift from the collection of epibenthic data using destructive methods to less destructive methods that include underwater visual surveys. South African mesophotic ecosystems are under-sampled compared to both their shallower counterparts. The Amathole offshore region is a historically unexplored region of the South African coastline. This study aimed to define and describe the benthic communities and identify the processes driving their distribution on the temperate shelf in the Amathole offshore region, using a Remotely Operated Vehicle (ROV). It also piloted the application of the Australian developed CATAMI classification to annotate images collected by ROV in South Africa. This survey combined 14 sites comprising 215 images from ROV and nine environmental variables from 30 to 100 m water depth. Multidimensional scaling and a cluster dendrogram produced nine benthic communities. Similarly, multivariate analyses (distance-based linear model and distance-based redundancy analysis and constrained binary divisive clustering analysis) of the environmental data revealed that substratum type and correlates of depth to be the main variables likely responsible for the observed biodiversity patterns. LINKTREE analysis revealed a depth break at 74 m which established the boundary between the upper and lower mesophotic zone in this region. Rhodolith bed communities were discovered in the upper mesophotic and are a welcomed novel ecosystem type for South African benthic ecologists. This zone was also characterised by communities of dense brittle star aggregations and macroalgal dominated reefs. The lower mesophotic zone was characterised sponge and gorgonians gardens. The use of morphospecies in image classification to define macrobenthic communities on an unexplored continental shelf was effective despite limited knowledge of species. This foundational biodiversity information informs marine spatial planning and spatial management efforts for the newly proclaimed Amathole Offshore Marine Protected Area and the greater Amathole offshore region.

Keywords

Temperate mesophotic ecosystems, Animal forests, Benthic invertebrates, River influenced

O26.2

Impact of ocean acidification on different life traits of the gastropods Hexaplex trunculus

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Abstract

Increased atmospheric CO_2 produced by anthropogenic activities will be absorbed by the oceans over the next century causing ocean acidification and changes in the seawater carbonate chemistry. According to the IPCC emission scenarios a reduction of 0.3–0.5 pH units is already expected by 2100. An observed effect of ocean acidification is the reduction of calcium carbonate saturation states, which inhibits calcification rates in shell-forming organisms or may cause dissolution of the existing shell, thus reducing shell resistance and increasing predation pressure. The present study aims to investigate the sublethal and synergistic responses of long term exposure to low pH and increased temperature on the murex gastropod *Hexaplex trunculus* (Linnaeus, 1758). Adult gastropods were maintained under controlled conditions of temperature (ambient; increased +3.7°C) and pH (ambient; reduced -0.3 units) for a long term period. Juveniles born and raised for more than one year under the same conditions were also used in the analysis. Effects on shell growth, density, porosity and structure thickness were investigated using micro-Computed Tomography (micro-CT) imaging techniques. In addition, the results of a feeding experiment are presented in order to evaluate the feeding efficiency and performance of gastropods under the controlled treatments. Marine molluscs support community structure and ecosystem functioning, therefore their capacity to develop normally under altered environmental conditions is important. Their potential plasticity to environmental factors makes them an ideal model for the study of study of adaptation to ocean acidification.

O26.3

Subtropical estuarine ecosystem function during drought conditions: case study of two South African estuaries

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Abstract

Provision of socio-economic and ecological goods and services by estuaries is dependent on all biological components functioning effectively within naturally variable environmental conditions. Global change is predicted to alter the natural variability of environmental conditions experienced by estuaries, such as rainfall patterns, potentially impacting ecosystem functioning. This study aimed to investigate and compare the ecosystem functioning of two subtropical South African estuaries, uMlalazi Estuary, a permanently open system, and uMdloti Estuary, a temporarily open/closed system during drought conditions. *In situ* data and literature-derived information were used to construct seasonal empirical food web networks for each estuary. We holistically assessed estuarine ecosystem functioning by examining food webs as energy networks of trophic connections ('interactions') between species or functional groups ('nodes'). Through the use of computational system analysis tools (e.g. Ecosystem Network Analysis (ENA)), ecosystem metrics based on the interactions between nodes were calculated, providing insight into the functioning of the ecosystems. Results of ENA analysis showed that the two ecosystems responded differently to similar drought conditions. uMdloti Estuary ecosystem size increased during periods of rainfall. However, there was no significant change in ecosystem structure and function between seasons, indicating that the ecosystem is temporally stable. The uMlalazi Estuary ecosystem size remained the same between seasons, however, cycling of energy, flow diversity, and overhead increased during periods of low rainfall. Both ecosystems are shown to be detritivory-based food webs, indicating a degree of stability and higher resilience to perturbations. The different responses of each ecosystem to drought conditions may be as a result of each ecosystems unique hydrological, physiochemical, and anthropogenic stress conditions. The current understanding of unique ecosystem responses to drought conditions, together with regional predictions of global change scenarios, enable forecasts of global change impacts on these ecosystems to be made with greater confidence.

Keywords

ecosystem network analysis, estuarine ecosystem function, drought conditions, global change

O26.4

Unraveling seasonal carbon-limitation of benthic nitrate-reduction in the coastal Baltic Sea

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Abstract

Excess bioavailable nitrogen (N) is the key driver of coastal eutrophication, thus knowledge on the fate of N in coastal systems is imperative for improving eutrophication mitigation measures. In the coastal Baltic Sea, benthic heterotrophic denitrification, the main process of bioavailable N-removal from a coastal system, has recently been suggested to be seasonally limited by labile organic carbon (OC) availability[1] - despite the system´s richness in labile organic matter from long-term eutrophication. This challenges our common understanding of the intrinsic link between C- and N-cycling, and highlights the need for a more advanced concept of OC availability. Hence, in this project, we (i) extensively characterized the biochemical composition of coastal OC beyond traditional descriptors of 'lability', applying techniques such as isotopic fingerprinting and Fourier transform ion cyclotron resonance mass spectrometry, and (ii) concurrently quantified benthic nitrate reduction rates both with and without addition of easily degradable OC (glucose), to ultimately confirm and understand proposed OC-limitation of denitrification in coastal sediments. All measurements were done in high temporal and spatial resolution at the southern coast of Finland, covering a three-month period from late winter to early summer that included the peak annual input of fresh organic matter to the benthic system by the phytoplankton spring bloom. First results will be presented and their implications for understanding seasonal N turnover and coastal eutrophication dynamics will be discussed.

[1] Hellemann D, Tallberg P, Aalto SL, Bartoli M, Hietanen S (2020) Seasonal cycle of benthic denitrification and DNRA in the aphotic coastal zone,

northern Baltic Sea. *Mar Ecol Prog Ser* 637:15–28

Keywords

nitrate reduction, organic carbon, coastal sediments, Isotope Pairing Technique

O26.5

Factors influencing carbon stocks and accumulation rates in eelgrass meadows across New England, USA

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Abstract

Increasing the protection of coastal vegetated ecosystems has been suggested as one strategy to compensate for increasing carbon dioxide (CO_2) in the atmosphere as the capacity of these habitats to sequester and store carbon exceeds that of terrestrial habitats. Seagrasses are a group of foundation species that grow in shallow coastal and estuarine systems and have an exceptional ability to sequester and store large quantities of carbon in biomass and, particularly, in sediments. However, carbon stocks (C_{org} stocks) and carbon accumulation rates (C_{org} accumulation) in seagrass meadows are highly variable both spatially and temporally, making it difficult to extrapolate this strategy to areas where information is lacking. In this study, C_{org} stocks and C_{org} accumulation were determined at eleven eelgrass meadows across New England, representing a range of eutrophication and exposure conditions. In addition, the environmental factors and structural characteristics of meadows related to variation in C_{org} stocks were identified. We assessed stable isotopes of δ13C and δ15N as well as % C and % N in plant tissues and sediments, measured grain size and ^{210}Pb of sediment cores, and assessed site exposure. Variability in C_{org} stocks in seagrass meadows stocks is well-predicted using commonly measured environmental variables such as grain size distribution. This study allows incorporation of data and insights for the northwest Atlantic, where few carbon sequestration studies have been conducted.

Keywords

Seagrass, meadows, carbon sequestration, stocks

O26.6

Van Dorn type horizontal sampling bottle for shallow estuarine waters: constructed with recyclable materials

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Abstract

Water sampling water from shallow estuaries, rivers, or lakes sometimes with difficult access to sampling points could be a paramount task. In shallow estuaries, the depth could be a little more than the height of the tide; thus, in low tide, the depth could be less than a meter; therefore, the typical tubular plastic bottles with open-closed stoppers such as Nansen, Niskin, Kemmerer, and Van Dorn bottles could be unfit for water sampling. During three consecutive years at four sampling stations in the shallow waters of the marginal Estero Salado (Gulf of Guayaquil, Ecuador), whose water depth is dramatically affected by semidiurnal tides; 12 horizontal tubular water samplers were designed, constructed, and used for water sampling in order to determine estuarine eutrophication. Five of these designs are presented. All of them use very cheap material including recycled ones. The main bodies were made from plastic components such as drinking water bottles (3 kg) or Acrylic/PVC discarded pipes; as stoppers or ends the rubber of toilet unblockers, corks, stainless materials, thin/thick rope, a "messenger" and a dead weight. Up to 80% of the used material was from recyclables and the rest can be found in any workshop. New material costs were around 30 US$ or less, and the time to design and construct 10-20 hours. The horizontal sampling bottles proved to be rigid enough for hard field conditions. The open ends bottles are submerged 50-80 cm, once on the depth required they move sideways or aligned to the current. Then a messenger closes the ends. A home tap water is used to dispense the water into a secondary bottle. One of the sampling bottles (with one end) was used to sample right from the surface oil-water layer. Blueprints of each design are presented as well as main eutrophication parameters.

Keywords

Horizontal sampler, shallow estuary, lab-made, bottle

O26.7

Multi-element profiles as a fingerprint to discriminate estuarine *R. philippinarum* populations

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Abstract

Filter-feeder bivalves such as non-indigenous *Ruditapes philippinarum* absorb and accumulate metals, resulting in multi-element signatures. The goal of this study was to analyse if multi-element profiles of *R. philippinarum* can discriminate between spatial and temporal patterns of estuarine bivalves' populations.

Spatial and temporal variability patterns of chemical profiles were assessed by collecting samples of *R. philippinarum* and sediment at i) three sites with different environmental and physiological conditions of clams, ii) located within two Portuguese estuaries (Tagus and Sado estuaries) and iii) sampled at three different occasions (May 2018, January 2019, May 2019). This sampling design hypothesized that there are significant differences in the bivalves' chemical profiles between estuaries, among sampling sites and among sampling occasions. The chemical elements were categorized according to the estuarine geomorphology sources (Se,Co, Ni and Cu), elements with function in metabolic processes of the clams (Mn, Fe, Zn and Cr) and elements derived from the anthropogenic inputs (As, Pb and Cd). The multi-element concentrations of clams' soft tissues and sediments were obtained using a powerful analytical technique, ICP-MS (inductively coupled plasma mass spectrometry). Multivariate differences were tested in multi-element concentrations of bivalves' soft tissues and sediments. Results revealed that Zn, Co, Ni and Pb were the main contributors for the chemical signatures of Tagus estuary populations, whilst for the Sado estuary populations were Cu, Fe, Cr, As and Cd. These elements were representative of all elemental categories and proved to be spatial and temporal habitat discriminators of bivalves' estuarine populations. The multi-element signatures of *R. philippinarum* as a natural tag derived from the physical and chemical conditions of its habitat can be considered as a potential rapid tool for ecological biomonitoring and habitat assessment, accounting for spatial and temporal habitat differences of estuarine populations.

Keywords

Multi-element signatures, Traceability, spatial and temporal elemental discriminators, habitat bioassessment

O26.8

Seasonal and spatial variability of CO2 emissions in a large tropical mangrove-dominated delta

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Abstract

Tropical estuarine systems are a key component in the transport of carbon to the open ocean and important sources of CO_2 to the atmosphere. However, many large tropical estuaries are still unaccounted for regarding their carbon dynamics and CO_2 fluxes. In this study, we aimed to understand the seasonal and spatial variability of CO_2 fluxes in the Parnaíba River Delta, the largest delta in the Americas. This delta is a pristine environment dominated by mangrove forests located in a climatic transitional coast, with marked seasonality in rainfall and river discharge. Four major channels and bays of the Parnaíba delta were sampled during dry and wet seasons. Continuous measurements of pCO_2, temperature, salinity, and wind velocity were taken, while subsurface water samples were collected in discrete stations to analyze for pH, total alkalinity, dissolved oxygen and chlorophyll-a. The seasonal variability of pCO_2 is mostly related to rainfall and river discharge, with important contribution of riverine CO_2 in both seasons. Significant correlation between carbonate system parameters and salinity was found in both periods, with average salinity significantly higher during the dry one. The ecosystem showed high spatial variability of pCO_2, with highest values in mangrove-dominated waters, moderate values in the freshwaters and lowest values in the coastal bays. These differences, together with the spatial changes of the variables sampled indicate that the pCO_2 variability is likely controlled by a combination of river and ocean water mixing, respiration, and primary production, in both seasons. Averaged fluxes per area gave the dry season fluxes significantly lower (56.92 ± 2.66 $mmol.m^{-2}.d^{-1}$) than during the rainy season (111.07 ± 56.34 $mmol.m^{-2}.d^{-1}$), indicating that the season variability of fluxes is important in the estimation of annual contribution of CO_2 by this type of systems. We acknowledge CNPq for the financial support (Grant nº 405.244/2018-5).

Keywords: CO_2; Estuaries; Mangroves; Season.

Keywords

CO2, Estuaries, Mangrove, Season

O26.9

Alive and dead foraminiferal assemblages at sandy beaches of Karachi coast-diversity, ecological distribution and responses to seasonal fluctuations

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Abstract

Many species of living foraminifera are considered as bioindicators in littoral habitats which help to analyze environmental health of the beach. Benthic foraminifera in relation to habitat conditions and seasonal influences was studied for the first time from Pakistan coast, based on 48 core samples collected monthly with the help of hand corer (diameter =3 cm) from four staions at two sandy beaches during 2014-2015. The aim of this research is to explore distribution of alive and dead benthic foraminifera from the studied beaches of Karachi coast with respect to physicochemical environment, sediment characteristics and seasonal fluctuations.

For this study the top 0-2 cm sediment slice was analyzed for both living and dead foraminiferal assemblages. A total of 6615 cm^{-2} specimens consisting of 3451 cm^{-2} dead tests and 3164 cm^{-2} living specimens were recorded which belong to 66 species out of which 47% species are miliolina, 42% rotaliina, 9% textulariina and 2% are spirillina. At Sandspit 3197 cm^{-2} specimens were recoded while a sum of 3418 cm^{-2} specimen were recorded from Hawksbay. The highest abundance was exhibited by rotaliina, milolina and textulariina respectively. The most dominant rotaliina species were *Ammonia beccari, Pararotalia stellata, P. vensuta, Elphidium crispum* and *E. advenum* respectively. SIMPER showed that average dissimilarity between foraminifera abundance at Sandspit and Hawksbay is 18.51%. *A. beccari and P. stellata* are the most similar species within stations at both sites. The highest foraminifera abundance was recorded in Northeast monsoon season (3232 cm^{-2}) and the lowest during pre monsoon season (398 cm^{-2}). pH, salinity, organic content, nutrients and sediment grain size appeared to effect the foraminiferal assemblages.The most influencing factor for foraminiferal diversity and abundance is monsoon season at both studied sites.

Keywords

foraminifera, sandy beaches, Karachi coast, Monsoon season

O27.1

Change of GCA performance on remediation of contaminated sediment by deposition of new sediment

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Abstract

Function of Granulated Coal Ash (GCA) on remediation of the contaminated coastal sediments has been proved over a decade. However, the performance of the GCA should be changed by several reasons. Deposit of new sediment on the GCA can lead performance degradation of the GCA by creating anoxic condition. Mesocosm experiment was carried out to investigate the effects of new sediment deposition on the GCA performance for coastal benthic remediation. According to the presence or absence of new sediment covering on the GCA, reductions of PO_4-P concentration were 90% and 81%, respectively. And H_2S concentration decreased by 100% and 67%, respectively. However, when the GCA was covered by the new sediments, the reduction of H_2S concentration was 28% lower than that of the Control. The main mechanisms of removal in PO_4-P and H_2S in the sediment were improvement of the sediment permeability, supplement of metal ions such as Ca, Fe, Mn from GCA, and decrease of SRB activity by increasing pH. Despite of new sediment deposition on the GCA with the thickness of several centimeters, decrease in concentration of PO_4-P and H_2S were observed although the efficiency of the GCA is declined.

Keywords

Coastal sediment, Granulated coal ash, Phosphate, Hydrogen sulfide

O27.2

Shoreline changes along the Barrier-Lagoon coast of Nigeria - a potential threat to beach front

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Abstract

The Barrier-Lagoon Coast is the most commercially thriving coast in Nigeria and borders her most densely populated state – Lagos. The Coast has the largest seaport in Nigeria. Extensive dredging and engineering construction carried out between 1905 and 1912 to enhance seaport activity and further effects of urbanisation, introduced instability in the shoreline of this region. This study is aimed at assessing the extent of coastal erosion within the Barrier – Lagoon Coast. Landsat Imagery data were used to delineate shorelines of various years namely 1987, 2000, 2010 and 2018. End Point Rate of change (EPR) and Linear Regression Rate of Change (LRR) were performed at 500 m interval using Digital Shoreline Analysis System (DSAS) to determine the rate of change. The determined rates were followed up with field verification. Five zones (A-E) were delineated based on the statistical results. Zone A showed EPR and LRR results that ranged from -4 m/yr. to -10 m/yr. EPR values in Zone B ranged from 23 m/yr to 51 m/yr while LRR values varied from 16 m/yr to 61 m/yr. In Zone C, EPR and LRR ranged from -9m/yr. to -16m/yr. Zone D EPR values ranged from -2 m/yr to 12 m/yr while LRR was from -2 m/yr to 13 m/yr. Only 29% of the shoreline in Zone D is erosive. In Zone E, EPR values ranged from -4 m/yr to -26 m/yr and LRR from -2 m/yr to -21 m/yr. The results show that 74 % of the 236 km Barrier-Lagoon Coast is threatened by erosion at rates ranging from 1- 26 m/yr. Using calculated rate of change, a 20-year shoreline position was predicted. Over 26.1 km^2 of beach front is estimated to be lost by 2038.

Keywords

Shoreline, Beach, Erosion , Rate

O27.3

The transnational urbanisation of the North Sea: Socio-economic and governance challenges resulting from the demands of a complex of uses and users

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Abstract

This interdisciplinary project aims to determine the sustainability of economic development while delivering the ecosystem services from which society obtains goods and benefits (Elliott, 2014). In essence, this means preserving the structure and functioning of the coastal and marine environment(s) while sustainably obtaining economic development. The North Sea is no different to this while becoming increasingly industrialised/urbanised. In particular, there are many port cities which not only support navigation and trade but also major infrastructure for constructing and supporting offshore energy, and resource extraction such as aggregates for building and shore protection and fisheries. The term urbanisation is taken here to include not only the areas covered by the population but also the reach of that population in using (and potentially abusing) marine resources. As such, the project uses a sub-set of North Sea urban and coastal areas - Hull, Bremerhaven and Esbjerg - to decide on the economic and environmental influence of each of these regions at different distances into the North Sea Basin. Then, in turn, to determine the influence of the North Sea on those coastal areas (i.e. the effects of storm surges, rising sea levels and industrial development). Ultimately, this will enable the determination of the most appropriate management and governance regime for the area - which is required to overcome the current approach covering sectors of human use (e.g. fisheries, navigation, recreation) and centred mainly on a single country approach to management. There is a need for a new way of governance, especially to accommodate the increasing role of the OSPAR Regional Seas Commission as a consequence of Brexit - which concurrently impacts how North Sea states will manage the area and attempt to achieve harmonised Maritime Spatial Planning.

Keywords

Marine Urbanisation, Marine Social-Ecological Systems, Marine Environmental Management, Complex Adaptive Systems

O27.4

Threespine stickleback as a successful species in the Anthropocene

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Abstract

Anthropogenic effects lead to fast environmental changes, which challenge the adaptive capacities of biological species and therefore alter their relative completeness. This results in the growth of some species and the decline of others. Small fish threespine stickleback Gasterosteus aculeatus, which has a negligible commercial significance, notably expanded its range during the last decades (Svalbard, Northern Land, Caspian Sea, upper and midstream of rivers entering the Black Sea) and drastically increased its abundance within the current range (Baltic and White Seas, Lake Constance). In the Baltic Sea, the increase of stickleback abundance is likely associated with eutrophication, which improves their feeding conditions and, via positive feedback mechanisms, facilitates further growth of the population. In the Arctic White Sea, the growth of stickleback is primarily related to increased temperature. In lake Constance stickleback actively prey on juvenile whitefish which is their food competitor. Thus, in different ecosystems, different factors resulted in an increase of the same species, which is unlikely due to chance and thus requires a special analysis. Stickleback has a number of characteristics allowing them to quickly occupy changing ecological niches: (i) small size and quick maturation; (ii) exceptional euryhalinity; (iii) high phenotypic plasticity with respect to feeding and habitats; (iv) ability for quick genetic adaptations; (v) armor structures effectively protecting fish from predators ; (vi) complex behavior, in particular protection of offspring by males and cannibalism; (vii) high tolerance to chemical pollution. These characteristics may provide stickleback competitive advantages in comparison with other species and contribute to a recent increase of stickleback abundance and distribution range under quick and unpredictable human-induced environmental changes. As this trend is forecasted to progress, one may expect further growth of threespine stickleback abundance and range. The study was supported by RSF grant 19-14-00092.

Keywords

threespine stickleback, Baltic Sea, population growth, White Sea

O28.1

Environmental impact assessment 2.0: genetic identification as a faster and cheaper method for marine environmental monitoring.

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Abstract

Environmental impact assessments (EIAs) evaluate the quality status of the marine environment often by using biotic indices based on abundance and number of species, which are morphologically identified. This method is time-consuming, labor-intensive and demands specific taxonomic knowledge. Here, we evaluate DNA metabarcoding as a faster and more cost efficient method for impact monitoring of sand extraction in the North Sea. Samples were taken in nine reference stations without sand extraction activity, and in 15 impacted stations, with different levels of extraction intensity (low, medium and high). Samples were first identified morphologically, and afterwards blended to obtain bulk DNA for DNA metabarcoding. Although a high number of unique species were found for each method (17% and 58% for the genetic and morphological method, respectively), most of these were low abundant (less than 100 reads or 5 counts). Moreover, species number did not differ significantly between both methods: more species were observed in high and medium impacted samples compared to low and reference samples. Beta-diversity also showed a similar pattern: a high, medium and low-reference sample cluster could be discerned, regardless of the method used. The quality status was assessed using the BEQI (Benthos Ecosystem Quality Index), where the overall Ecological Quality Ratio (EQR) is calculated relative to the observed variation in the reference samples. Again, the same trend was discerned for both methods: higher EQR values for low and medium impacted locations compared to high impact locations. Furthermore, we calculated that genetic processing of the samples was 45% faster and 27% cheaper compared to morphological processing. This study indicates the potential of DNA metabarcoding for EIAs in the North Sea.

Keywords

Environmental Impact Assessment, COI Metabarcoding, Macrobenthos, North Sea

O28.2

A reliable DNA barcode reference library for benthic invertebrates, crucial for the biomonitoring of the North Sea

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Abstract

Several EU directives (e.g. MSFD) and OSPAR guidelines require transitional sustainable management of marine resources. Benthic organisms are key components in environmental impact assessments. Nevertheless, their use as bioindicators can be constrained by the time- and cost-consuming processes needed for their morphological identification. The recent advances in high-throughput sequencing, particularly DNA metabarcoding can provide an alternative to morphology-based approaches. The main limitation for DNA-based biomonitoring projects is the considerable investment needed to build high-quality and curated DNA sequence reference libraries for species identification. Interreg project GEANS (Genetic Tools for Ecosystem Health Assessment in the North Sea Region) is a transitional co-operational project among nine institutions across the North Sea aiming to implement and mainstream accurate, fast, cost-effective DNA-based tools in routine biomonitoring. For this reason, GEANS is developing a curated DNA reference library based on mitochondrial cytochrome c oxidase subunit I (COI) for the North Sea macrobenthos serving as the backbone of all the molecular protocols. For the collection of the macroinvertebrates, a targeted sampling campaign is underway across the North Sea, while existing collections are being scanned. Macrobenthic specimens are being processed following a series of standardise work flows covering sampling, morphological identifications, molecular lab processing and data handling. GEANS reference library, currently, holds DNA barcodes for 3513 specimens comprising 11 phyla, 28 classes, 80 orders, 280 families, 431 genera and 591 species (37 non-indigenous species). GEANS reference library covers so far over 30% of North Sea species and its constantly enriched. All specimens are photographed and together with the accompanying sequences, collection and taxonomic data are archived in a dedicate BOLD project, while voucher specimens are archived at three institutes (SaM, Naturalis, ILVO). Once available, this DNA-library will support the implementation of fast, cost-efficient and reliable DNA-based identifications and subsequently environmental health assessments in the North Sea.

Keywords

North Sea, COI reference library, benthos, barcoding

O28.3

Can we assess anthropogenic effects on intertidal benthic fauna with eDNA metabarcoding?

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Abstract

As the value of marine biodiversity is increasingly recognized, innovative methods to assess this biodiversity are needed. Current methods of morphological examination are often labour-intense, impeded by specialized taxonomic knowledge, invasive and often limited to larger species groups. In the past decade, eDNA metabarcoding methods combined with next generation sequencing have been successfully implemented in various studies to assess (marine) biodiversity. The quality of the biodiversity assessment is dependent of many factors, including methodological impediments and the ability to capture the DNA which truly reflects the community.

We explored different methods within the DNA metabarcoding workflow to assess marine benthic biodiversity. For this, we used the benthic community from the intertidal Wadden Sea as a case-study site. This benthic community is well studied and taxonomic knowledge is available. Hence, the outcomes from the DNA metabarcoding methods could be compared and related to the outcome of the traditional morphological method. Firstly, we investigated the influence of different extraction protocols, different primer-sets and bioinformatic pipelines on the outcomes of a metabarcoding study. From the different set of approaches, we selected a best-practice for this specific community and assessed the quantitative performance off this approach. Subsequently, we explored whether these metabarcoding methods were suitable to assess anthropogenic effects, in the form of intertidal dredging, on the benthic community.

In our study we found that, although quantitative aspects of the eDNA metabarcoding approach were limited, this method is well suited to assess changes in the benthic community due to dredging activities. Also, the eDNA metabarcoding methods were able to reflect recolonization patterns in the meiofaunal and macrofaunal benthic community.

Keywords

eDNA metabarcoding, Benthic community, Quantification, Anthropogenic activities

O28.4

Assessing the ecological status of bacteria and macroinvertebrates, using molecular-based indices, inspired in the AMBI approach

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Abstract

Monitoring and assessment of benthic communities are routinely undertaken using morphology-based benthic indices, being AZTI's Marine Biotic Index (AMBI) and multivariate-AMBI (M-AMBI), two of the most successful worldwide. Based on the AMBI approach, in which the taxa are assigned to ecological groups, depending on their response to human pressures (from sensitive to opportunistic responses), some molecular-based approaches have been proposed. Among them, microgAMBI has been applied in some locations worldwide to assess the status of bacteria. In addition, the genomic version of AMBI (gAMBI) has demonstrated to yield results comparable to the morphological version, when assessing benthic communities. As the official method to assess benthic status in several European countries is M-AMBI, we are trying in the Basque Country to set the reference conditions for a reliable genomic version (M-gAMBI). In this contribution, we present an overview of the current development of these three genomic indices, with some examples of application and compared results to the morphological versions. A discussion on the problems associated to these indices is also included. We consider that the findings of our research are of paramount importance for managers, since any new method or modification of an existing assessment method, needs to demonstrate that the results obtained when assessing the status are similar to those morphological-based methods, already approved and intercalibrated.

Keywords

bacteria, macroivertebrates, biotic indices, metabarcoding

O29.1

Review of Japan's activities in pursuit of balancing water quality management and bio-productivity in the Seto Inland Sea

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Abstract

The Seto Inland Sea is the largest enclosed coastal sea in Japan and the people have coexisted with the nature of the Sea, being historically benefitted from the Sea. With concentration of both population and industries and the reclamation programs, however, we lost much area of seagrass beds and tidal flats while the water quality deteriorated notably in the high economic growth in 1960s. We have therefore conducted environmental water quality management activities based upon the Water Pollution Control Law and the Law concerning Special Measures for Conservation of the Environment of the Seto Inland Sea through controlling COD, N and P to prevent eutrophication.

Our activities have improved the water quality, seeing less incidents of red tides. We however continue to observe red tides and water areas where no to little oxygen is present in some areas in the Sea. We also recognize new issues around bio-diversity and bio-productivity. Conservation and restoration of habitats are still behind where we should be. Another possibility suggested is that excessively reduced level of nutrients can negatively affect bio-productivity.

We need to address such complicated issues as caused by increased nutrients as well as caused by decreased nutrients in some areas. In order to grapple with such issues, not only local governments but also various stakeholders need to actively participate in drawing the ideal state of the Sea in the respective area perspective. For this initiative, we submitted to the Diet the bill of amendment of the Law concerning Special Measures for Conservation of the Environment of the Seto Inland Sea in 2021 to facilitate the introduction of the new system for nutrients control.

Keywords

inland sea, policy making, water quality management, tidal flats

O29.2

A study on china's marine ecological red-line policy

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Abstract

The Marine Ecological Red-line System is China's own protection system aimed at preserving the ecological environment in terrestrial and marine areas. Since the system was fully implemented in June 2016, almost all coastal provinces and cities in China now have marine ecological red lines.

This study first clarified the characteristics of the red line system by deciphering the policy documents on the marine ecological red line system. Then, from the perspective of institutional analysis, I analyzed the differences between China's marine ecological red line system and the marine functional zone system, the marine protected area system, and clarified the position of the red line system in the spatial planning system.

The purpose of the marine ecological red line system is to maintain the integrity and stable functioning of the ecological system structure. Each red line area is defined by the degree of vulnerability of the ecological environment and is not necessarily contiguous in space. From the perspective of the management system, an important feature of the marine ecological red line system is that it allows for the issuance of bans on activities in protected areas. Once an area is demarcated as a red line area, it is prohibited to revoke or reduce the area. Taking into consideration the factors mentioned above, it's able to say that the marine ecological red line system is a higher-level concept.

On the other hand, China's marine protection system, adopts a top-down approach, which means that little consideration is given to social factors such as the stakeholders who use the sea area from the stage of establishing protected areas, and the evaluation of the system's effectiveness focuses on the weight of indicators related to management. In the further research, it is need to determine the performance, and challenges of the marine ecological red line system.

Keywords

Marine protection system, Red-line system, Spatial planning system

O29.3

Impact of climate changes on water and nutrient transport in central Japan and leading to climate change adaptation strategies

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Abstract

The temperature in Japan has been rising 1.7 times faster than the world's average due to ongoing global warming. The effects of the dramatic change have also begun to appear in the weather and the water cycle of Toyama, since Toyama is well-watered having an annual precipitation (~2,300 mm) about four times as high as that of the world's cities with the same latitude. The rise in temperature has turned snowfall into rainfall, and as a result, the amount of snowfall in this area has decreased by up to 50% over the past 40 years. The reduction in the snowfall caused a deterioration in the function of water storage and groundwater recharge. These shifts are expected to increase river water and shallow groundwater volume and a shortened residence time before flowing to the coastal ocean, eventually decreasing nutrient concentrations in the terrestrial water. In order to adapt to the continuing global warming, it is vital to understand the current status of the water and nutrient dynamics in this area and then adopt appropriate measures based on scientific evidence in cooperation with the government. A three year new project (Environment Research and Technology Development Fund, 2-2101) has started including three parts: (1) elucidation of the mechanisms of water and nutrient cycling in the region, (2) identification of factors causing changes in these processes due to climate change, and (3) future forecasts based on observational data and consideration of adaptive measures. Our goal is to contribute the necessary information to the government so that appropriate nutrient management strategies and efforts to conserve sustainable water and nutrient cycles can be implemented for adapting to climate change.

Keywords

nutrient transport, halved snowfall, climate change, adaptation strategies

O29.4

Effects of the Mose closure on ecosystem functioning in the Venice lagoon (northern Adriatic Sea): A preliminary experimental study

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et al

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Abstract

The MOSE, consisting of rows of mobile gates installed at the three inlets, will be able to isolate the Venice lagoon temporarily from the Adriatic Sea during extreme high tides. We set up a 48h field experiment to investigate how the lagoon ecosystem will be affected by a prolonged period of segregation from the oxygenating seawater by artificially secluding small portions of the lagoon. We simulated the worst-case scenario, i.e. the potential effects of prolonged MOSE closure times on an organic-enriched shallow (<75 cm) area often subjected to hypoxia. In July 2019, we positioned 18 enclosures (~ 0.8 m^3 each) in Palude di Cona to study short-term (4h, t1) and long-term (24h, t2; 28h, t3 and 48h, t4) effects on planktonic and benthic communities at different trophic levels (prokaryotes, microalgae, consumers). We registered lower oxygen concentration inside the enclosures (mean O_2: 58.7±14.8% inside *vs* 73.5±21.5% outside) though hypoxia was not reached. From t0 to t4, we observed a mean reduction of 68% for Chl *a* and 91% for Primary Production (PP) in the water inside the enclosures. Contemporaneous molecular analyses (DNA metabarcoding) performed on prokaryotes and microalgae revealed a 32× increase of the Alteromonadales and a 10× decrease of Synechococcales relative abundances, and a 4× decrease of the planktonic diatom genus *Thalassiosira*. In contrast, Prokaryotic C Production (PCP) increased from t0 (8.06-9.36 µgC $L^{-1}h^{-1}$) to t2 (12.97-19.30 µgC $L^{-1}h^{-1}$) likely stimulated by the nutrient efflux from sediments. In sediments, we obtained the highest PCP rates at t1 whereas PP more than doubled after 48h due to an abundant benthic diatom community. Our results suggest that the lower hydrodynamic regime induced by the MOSE closure could likely lead to the deposition of the suspended material over time, affecting the main biological processes and the pelagic-benthic coupling in the Venice lagoon.

Keywords

ecosystem functioning, plankton , benthos, Venice lagoon

O29.5

Response of phytoplankton resting stage communities to chemical contamination in two Mediterranean port areas: Trieste (Italy) and Haifa (Israel)

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Abstract

The encysted phytoplankton communities in surface sediments of two Mediterranean port areas were investigated to highlight how anthropogenic activities could shape the structure of the phytoplankton both in the sediments and in the water column in those areas. In fact, cyst assemblages are able to respond to changes of environmental conditions, including variations in nutrient levels or pollution. This response could be a direct consequence of the exposure of cysts in contaminated sediments but also the indirect effect of variations in the water of active stages of species with different biological and/or ecological properties.

The ports of Trieste in Italy and Haifa in Israel are two of the largest in the Mediterranean. Both have different terminals, including general cargo, chemical and oil piers and cruise terminals.

Besides this, the two areas are characterised by high concentrations of contaminants derived from the proximity of the industrial area at Trieste site and the enclosing of the Kishon estuary, the most polluted river of Israel, in the port of Haifa. The cyst assemblages were analysed in surface sediments collected at sampling sites chosen to represent different environmental features of the two ports.

The analyses revealed a clear signal of chemical pollution and change in the trophic status of the system was observed in both areas, in terms of increase of heterotrophs and species linked to high levels of heavy metals contamination. Conversely, different patterns were found among the sites inside each port and in the indices of ecological diversity between ports.

These results confirm the influence of anthropogenic activities on the structure of plankton communities. Yet, they concomitantly underscore the need to improve the knowledge of local communities, in order to correctly estimate the effects of pollution on plankton and identify species as biological indicators of these effects.

Keywords

phytoplankton, resting stages, port, Mediterranean

O29.6

Effects of breakwater deployment on the life-history traits of the caramote prawn penaeus kerathurus (forskål, 1775) in the adriatic sea

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Abstract

A century ago, in the Adriatic Sea, *Penaeus kerathurus* was a rare species without interest for the local fishers. Its abundance has been in continuous increase in the last 30 years, in countertendency with a general decrease of fisheries resources. Besides the expression of the meridionalization phenomenon, some authors have hypothesized this change is generated by synergic action of multiple factors. Thus installation of breakwaters, to prevent coastal erosion, resulted in extension of suitable nursery grounds with enhanced recruitment of post-larvae, and seasonal trawling ban delays recruitment of juveniles into the fishery. The aim of this study was to verify if the extensive construction of breakwaters along the western Adriatic coast, since the late Fifties of the past century, could affect the life-history traits of caramote prawn. Samplings were carried out, with an experimental beam-trawl, from July 2013 to September 2014, in an area protected by breakwaters and additional samplings were carried out in areas without breakwaters and again in summer 2016 and 2018. Water temperature was recorded at each sampling. Results evidenced a high density of juvenile caramote prawns within the protected area in summer, with maxima of 0.36 and 1.15 ind/m^2, respectively in August 2013 and August 2018, whereas almost zero specimens were caught in areas not protected with breakwaters. This is a strong indication that the narrow strip of shallow artificial “lagunar habitat” created by breakwaters, acts as a suitable nursery area for *P. kerathurus*. Machine learning techniques highlighted the correlation of relative abundance of juveniles in these nurseries with environmental parameters. In particular, random forest analysis indicated the photoperiod as the most important independent variable; regression tree clearly depicts this relationship, showing also how the water temperature, the second most important variable, explains the sharp decrease in density at the autumn offshore migration.

Keywords

Breakwaters, Penaeus kerathurus, Life-history traits , Adriatic Sea

O29.7

Effects of the MOSE closure on meiofauna in the Venice lagoon (northern Adriatic Sea): preliminary results from a mesocosm study

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Abstract

Among the coastal urban ecosystems, the Venice lagoon represents an inimitable case study since the human attempts to preserve the environment, the cultural heritage and the economic activities led to the construction of a large maritime engineering work, i.e. the MOSE system. It consists of rows of mobile gates installed at the three inlets aiming at isolating the lagoon temporarily from extreme high tides. Despite the protection that this system should offer to Venice, some concern has been raised about the effects on the environment of the prolonged lagoon segregation from the oxygenating seawater. To explore this issue, an in situ mesocosm experiment was set up in order to simulate a 48h MOSE closure. In July 2019, we positioned 18 enclosures (~ 0.8 m3 each) in Palude di Cona to study short-term (4h, t1) and long-term (24h, t2; 28h, t3 and 48h, t4) effects on plankton and benthos at different trophic levels. A special focus was dedicated to meiofauna due to their pivotal role as the link between micro- and macrobenthos. Since in a time span of 48h a change in meiofauna diversity could not be detectable, we investigated if the organisms respond to the artificial closure in terms of migration through the sediments. In each mesocosm, two sediment cores (10 cm2 inner surface) were collected, immediately subsampled in 5 sediment layers (0-1 cm, 1-2 cm, 2-3 cm, 3-5 cm and 5-10 cm) and fixed in 4% formaldehyde. Preliminary results suggest that both the two dominant meiofaunal groups, i.e. the nematodes and the harpacticoid copepods, tend to preferentially migrate towards the surface sediment layers within the experimental 48h time span. The dataset with a focus on nematode genera and their biological traits will provide more insights into the effects of the MOSE closure on these ecologically fundamental organisms.

Keywords

Meiofauna, urban ecosystems, mesocosms, artificial lagoon segregation

O30.1

Monitoring and modeling of ocean pelagic microplastics

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Abstract

Laboratory-based studies have suggested that marine organisms can be harmed by ingesting microplastics. The present study shows a secular variation of pelagic microplastic abundance in the Pacific Ocean from 1957 to 2066, based on a combination of numerical modeling and transoceanic surveys conducted meridionally from Antarctica to Japan (Isobe et al., 2019). Marine plastic pollution is an ongoing concern especially in the North Pacific. The results of our numerical model suggested that the weight concentrations of pelagic microplastics in the western and central North Pacific would increase approximately twofold (fourfold) by 2030 (2060) from the present condition, if the amount of plastic waste entering the ocean keep on increasing. According to the predictions of the present model, weight concentrations around 10^3 mg m^{-3} are likely to occur by the 2060s in the upper ocean. Therefore, pelagic microplastics will be potentially harmful to marine organisms exposed to dense concentrations in the western and central North Pacific. However, at the present time, there remains a large gap between microplastic observations (hence, modeling) and laboratory-based studies with respect to sizes of microplastics to which aquatic biota are exposed. The numerical model is now expanded to the world's ocean.

Keywords

microplastics, ocean

O30.2

Seasonal variation of microplastics pollution in Sishili Bay of the North Yellow Sea

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Abstract

Marine microplastic pollution has become one of the highly concerned global environmental issues, especially in coastal seas. This study examined the abundance of microplastics and their polymer shapes in the surface, bottom water, rivers, and the bottom and beach sediments of Sishili Bay along the coast of the North Yellow Sea. The field surveys on microplastics were conducted seasonally in 2019. Seawater was sampled in 20 L bracket, and bottom sediment samples were collected using box corer. The results showed obvious seasonal variation of microplastics both in water and sediment. The higher microplastics abundance occurred in winter in the surface water and on beaches while lowest abundance in summer. Conversely, microplastics abundance in the bottom water and bottom sediment showed higher abundance in summer, suggesting that vertical movement played a significant role in the bottom distribution. The result of sediment trappers showed a quick settling rate in this area which resulted in microplastics deposition. Forced by wind and currents in winter, there were more microplastics in the sea water. Fibers predominated microplastic shapes in both seawater and sediment, following by fragments, films, foams and pellets. The composition change of shapes could reveal the source of microplastics, the debris of cages, fishing lines and floats producing by aquaculture farming was the main source of microplastics.

Keywords

microplastics, seasonal variation, hydrodynamics, aquaculture farming

O30.3

Influence of pollution sources on policy alternatives of Marine plastics governance in China: A case study of Xiamen

Boyu Wang, Siqi Ji, Qinhua Fang

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Abstract

As a serious problem, marine plastic has been widely concerned on a global scale. However, most studies have focused on the exiting status of marine plastic in the environment, and the negative effects on the ecosystem and human society. There are fewer studies investigating the marine plastic pollution source to evaluate alternatives for environmental public policies. Therefore, this study firstly established a comprehensive quantitative system of marine plastic waste with coastal population, the management level of waste, hydrological conditions of the basin, and other related parameters. For this study, we mapped marine plastic pollution sources in Xiamen bay, China, including land streams, marine aquaculture, coastal tourism activities, and microplastics from sewage outlets into the sea. The second was to create and map the alternatives for public policies related to pollution emissions. It expected to provide policy recommendations for marine plastic pollution prevention by comparative analysis of different plastic governance policy alternatives. This research used a multicriteria model-Analytic Hierarchy Process(AHP) and Fuzzy logic to weigh each pollution source of quantitative results and policy alternatives. In this study, we implemented quantitative research and policy analysis from the perspective of pollution sources, which makes a direct comparison of the emissions from different sources. It would be beneficial for the government to formulate corresponding policies and organized the work of prevention and control in marine plastic pollution from different sources more effectively.

Keywords

marine plastic source, quantitative research, policy alternatives, mapping

O30.4

A probability-based model of the beach process of marine plastics: Application to Hiroshima Bay

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Abstract

To comprehend and predict the adverse effects of marine plastics on the marine environment, it is necessary to estimate the standing stock of all categories of marine plastics in the marine reservoirs and the fluxes between them. Specifically, understanding and modeling the beaching-stranding-backwashing process, that is, the beach process, of the plastics will be a major issue to be addressed in the coming years. Here, we propose a model of the beach process of marine plastics by introducing beaching and backwashing probabilities. The backwashing probability was estimated from the average residence time of the beached plastics and the beach width, and then the beaching probability was from the flux-balance assumption between the beaching and backwashing plastic fluxes. The model was validated by means of linear system analysis and particle tracking experiments in a simple periodic channel. We then applied the model to Hiroshima Bay, where serious FPS pollution originating from oyster aquaculture rafts spreads out. The parameters of the model are the residence time (τ) of plastics on the beach and the partitioning coefficient (P_0) of the plastic count densities between the sea surface and the beach. In this study, we employed the following values: τ = 14/100 d; P_0= 3,050. Comparing the partitioning coefficient and the count densities among the beaches with the field survey, τ =100 d case reproduced well the observations. The simulation demonstrated that about 80% of FPS microplastics are on the beaches and the remains drift on the sea surface. Marine plastics with smaller specific gravities like FPS plastics are likely to be highly accumulated on the beaches. The maximum age of FPS microplastics was about 20 years, despite τ was set to 100 d. In the future, the degradation process could be implemented by using the age of the plastic.

Keywords

marine plastic, beach process, probability-based model

O30.5

Tiny Plastics: An issue solely for our oceans, or ubiquitous environmental pollutants?

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Abstract

Plastic materials are ubiquitous in the marine environment, and with an increase in public concern are considered pollutants of emerging concern that have caught the attention of the scientific community. With the rapid increase in production and use of plastic materials, plastic debris continues to accumulate in the environment where they can fragment into smaller pieces, with fragments < 5 mm typically defined as microplastics and fragments < 1 µm defined as nanoplastics. We know that plastics occur in the marine environment but it is widely acknowledged that many of the microplastic occurrence studies are not considered fully reliable and that there is a need to improve the quality assurance of occurrence studies on microplastics.Subsequently, even though we know that tiny plastic debris is present in every compartment of the environment, we do not know exactly how much is present.

With an emphasis on plastics as an emerging pollutant, new analytical techniques for determining the concentrations of plastics have been developed to better understand emissions and environmental exposures to plastics. Current focus is on filling knowledge gaps through providing a quantitative assessment of plastic residues in seafood species, including determining human plastic ingestion from consumption of seafood and potential plastic contamination from packaging and handling processes in seafood preparation; emissions in biosolids (treated sewage) to the terrestrial environment, determining emissions of synthetic fibers from dryer loads to the indoor environment; understanding the fate of tyre wear particles on the aquatic environment; understanding how different biological and chemical factors interact with micro and nanoplastics, and how it affects their impact, behavior and fate in aquatic ecosystems; and investigating the dietary exposure of Australians to microplastics from common every day food items.

Keywords

Microplastic, seafood, health, exposure

O30.6

Microplastics Pollution around Coral Reefs in Samui Island, Southern Thailand

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Abstract

Microplastics pollution has recently drawn worldwide attention, and may have negative effects on ecosystems. Microplastics pollution has been confirmed in the world, and there are concerns with biological effects. Main objectives of this study were 1) development of a pretreatment procedure for microplastics larger than 10 μm and 2) to understand the occurrence of microplastics larger than 10 μm around coral area. In this study, we investigated the microplastics around the coral reefs of Samui Island in southern Thailand.

In October 2019, surface water, middle water, and sediments were collected at three sites around the coral reef in southern Thailand. Collected samples were pretreated by H_2O_2 with 55 ^oC and $FeSO_4$ in Thailand. Density separation by NaI (5.3M) also was carried out in Thailand. The components of microplastics were identified by FTIR and μ-FTIR (Agilent) in Japan.

Microplastics concentrations were from 761 to 9,690 particles/m^3 (first survey), and from 1,860 to 6,680 particles/m^3 (second survey), respectively.

We reviewed 31 papers with biological effects of microplastics on aquatic biota. Mass densities of microplastics were calculated from the number densities of microplastics in this study.

Average mass densities of microplastics were from 179 to 528 mg/m^3 around coral reefs in Samui Island, southern Thailand in this study. They almost reached to the 1,000 mg/m^3.

Keywords

microplastics, coral, Thailand

O30.7

Paints are major sources of microplastics in European rocky intertidal habitats

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Abstract

Microplastics (< 5 mm, MPs) are omnipresent in oceans worldwide. Due to their small size, MPs are ingested by various animals. It is well known that MPs derive from small industrial plastics (primary MP) and larger degrading plastic waste (secondary MP). More recently, paint chips containing MPs have been reported from pelagic habitats. Such paint chips derive, for example, from plastic-based paints that protect ships from corrosion. However, compared to the expanding knowledge on pelagic MPs, information on MPs in rocky intertidal habitats and animals is scant and limited to filter-feeders, such as mussels and barnacles, that primarily contain MP fibers from synthetic cloths.

Therefore, we examined 24 water samples and 130 herbivorous snails (common topshells that graze on microalgae) collected from wave-sheltered and wave-exposed rocky intertidal habitats in Helgoland island (North Sea), Cap Ferrat and Giglio island (Mediterranean) and Madeira island (Atlantic Ocean) for MPs using micro-Fourier-transform infrared (µFTIR) spectroscopy. In total, we ran 362 individual µFTIR measurements. MP loads were similar across wave exposure and locations with 2.4 ± 0.8 MPs / L water (mean ± SE), 0.4 ± 0.1 MPs / snail individual and 1.0 ± 0.2 MPs / g snail wet weight suggesting that MPs are common in rocky intertidal habitats. Interestingly, large proportions of the water (21 %) and snail MPs (52 %) consisted of paint chips which shows that paints are major MP sources in the rocky intertidal. Thus, our study suggests that future MP research in rocky intertidal habitats and organisms should evaluate paint chip abundance to check whether (and by how much) paint chips contribute to MP contamination.

Keywords

paint chips, snails, FTIR, synthetic polymers

O31.1

A new in-situ annular flume for measurements of the erosion threshold on intertidal flats

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Abstract

Critical bed shear stress for sediment erosion is one of the most important parameters in sediment transport process. In-situ measurements of erosion thresholds without disturbing the bed sediment is necessary for clay and silt because of their complex properties. This study aims to develop a new in-situ device to measure the critical shear stress for sediment erosion in the intertidal zone, with the advantage of generating uniform bed shear stresses. At the design stage, the Fluent software was used to model the flow structure and bed shear stress distribution in the flume to determine the optimal rotating speed ratio of each part. At the next step, a series of laboratory experiments are accomplished in the flume to verify the numerical results. Finally, the flume was applied on the muddy tidal flats located along middle Jiangsu coast to measure the erosion threshold. Results reveals that uniform bed shear stress can be generated in the testing area when the inner cylinder, outer cylinder rotate at the optimal speed ratio. The test of sediment incipient motion shows similar results with that was done in Laboratory Annular Flume, which verifies that the designed flume is stable and reliable in obtaining the critical bed shear stress of field sediment.

Keywords

very shallow water, velocity profile, suspended sediment profile, field measurement

O31.2

Observation and simulation of concentrated benthic suspension in the high-turbidity estuary

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Abstract

Concentrated benthic suspension (CBS) is a unique sedimentary feature in high-turbidity estuaries, where it can make a rapid contribution to morphodynamics. Insufficient field measurements and fixed-point monitoring lead to deficient understandings of the formation, transport, and breakdown of the CBS under extreme weather conditions. A field survey was conducted in the Changjiang Estuary during the period of turbidity maximum, just after Typhoon Haikui. The measurements captured the formation of the CBS beneath the suspended layers, particularly around the lower reach of the North Passage. The thickness of the observed CBS gradually decreased landward along the channel, with the maximum value reaching ~0.9 m. The major features of the observed storm-induced CBS were simulated using the Finite-Volume Community Ocean Model (FVCOM). The results indicated that the initial appearance of the CBS was the result of a typhoon-intensified, salinity-induced stratification in the outlet region. The subsequent landward propagation of the CBS was driven by the combined effects of the CBS-induced mud-surface pressure gradient force and saltwater intrusion near the bottom. Weak mixing during the subsequent neap tidal period sustained the CBS as it rapidly extended into the middle region of the North Passage. This produced a large velocity shear at the interface of the FM and upper suspension layer, increasing the entrainment from the CBS to the upper suspension layer. As a result of the increased tidal mixing, the CBS weakened and then finally broke down in the subsequent spring tidal period.

Keywords

sediment, concentrated benthic suspension, storm impact

O31.3

Influences of the Indian Ocean Dipole on monsoonal oceanographic features in the Gulf of Thailand based on a 3D hydrodynamic model

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Abstract

Regional atmospheric states were reported to affect the oceanography of the Gulf of Thailand (GOT). Among them, the influences of the Indian Ocean Dipole (IOD) on the GOT oceanography have not been described sufficiently. Delft3D-FLOW model was used to investigate those impacts during the period between 2016-2020 using salinity and temperature condition from HYCOM/NCODA analysis dataset, ECMWF-ERA5 meteorological analysis data and tidal data retrieved from OTIS-TPXO model. Preliminary results revealed the notable influences of the IOD during the southwest monsoon (SWM) and the northeast monsoon (NEM) in terms of water volume transport, salinity and water temperature at times. During the positive IOD phase in SWM 2019, wind speed over the GOT increased, and temperature and salinity at the near surface rose when compared with the conditions during the neutral phase. The increased wind speed enhanced inward flow from the South China Sea (SCS). During the extreme negative phase of IOD in SWM 2016, inward flow from the SCS was promoted, and near surface salinity rose significantly when compared with those during the neutral phase and positive phase. During positive IOD phase in NEM 2020, temperature in the upper GOT and the south of the GOT mouth decrease. Salinity of the entire GOT were higher than those during the neutral phase. Inward flow and outward flow decreased during this season. It can be noted that weaker wind speed over the GOT were observed during both El Niño and positive IOD phase but near surface temperature and salinity distribution patterns were different. Based on three-dimensional hydrodynamic models, this study was able to simulate the inter-annual variability of monsoonal oceanographic features in the GOT. Future works include the investigation of controlling mechanisms over the observed changes, effects of the IOD during the inter-monsoon and analysis with longer periods to reconfirm the findings.

Keywords

3D hydrodynamic model, Indian Ocean Dipole, Gulf of Thailand, monsoonal oceanographic features

O31.4

Monsoonal sediment flux and the hydro-morphodynamic characteristics of the lower Karnaphuli river of Bangladesh

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Abstract

The lower Karnaphuli River is one of the most significant segments that hold the largest seaport of Bangladesh, supporting the country's major economic activities. But sedimentation due to considerable catchment area and river morphology are the significant issues in the proper functioning of the port. This investigation has encompassed estimating the total sediment flux and the hydro-morphodynamics of this segment of Karnaphuli River during the monsoon season of 2020 when the stream discharge reaches its maximum. The suspended sediment concentration was measured using a modified depth-integrated pressure difference sampler, and the bedload transportation was measured using a 250 mm mesh net mounted in a Helley-Smith bedload sampler from six points of two cross-stations. The study followed the standard methods and equations to calculate the hydrodynamic parameters of the river channel. The study revealed that the average suspended sediment transport rate was around 1940.31 m^3/s with a sediment concentration of 813.98 mg/L. The average bedload transport rate was found around 0.82 kg/s-m in downstream station, and the bedload transport rate of upstream station was 0.52 kg/s-m, where the river is 31.2% narrower than the downstream. The average daily total sediment load was about 0.529 million tons in the lower channel. The average bed shear stress was 2.14 $N/m^{2,}$ and the critical bed shear stress was 0.165 N/m^2. The considerable concentration and transport rate of suspended sediment confirm it to be the primary transport mode contributing about 91% of the total load averagely. The value of total sediment yield per day in monsoon indicates it to be the controlling factor of the annual sediment budget and the morphology of the channel basin. The findings of bed shear stress and critical bed shear stress may direct the mobility of bed particles, indicating possibility of erosion in the lower channel.

Keywords

Sediment flux, Suspended load, Bed load, Hydrodynamics

O31.5

Impact of climate change on longshore sediment transport capacities of sandy beaches in African

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Abstract

Climate is an important issue for coastal managers particularly when long term planning is concern. The impact of climate has been shown by different studies to have significant influence on coastal processes with adverse impact on water levels and shoreline on the global and regional scale particularly in the developed regions for example in Europe. Continental wide analysis of climate change effect on Africa's sandy coastlines is presented here focusing on sediment transport. The Longshore sediment transport (LST) is a key process driving beach erosion/accretion and shoreline change in general. Changes in future transport capacities along the continents coastline were assessed under different climate scenarios (the Shared Socioeconomic pathways (SSP) 126, 245 and 585).Wave parameters were derived from the Coupled Model Intercomparison Project phase 6 (CMIP6) experiments specifically the First Institute of Oceanography-Earth System Model version 2.0 whereas LST were simulated using the famous CERC empirical model. Median (5 -95 percentile) changes in annual mean transports relative to the historical condition were (respectively for SSP125 SSP245 and SSP585) 3.9(0.3-79)%, 4.6(0.3-88)%, and 4.9(0.4-84)% for the whole continent with some locations (~5%) show very high (95-200%) change. The magnitude of changes increases towards the end of the century. The impact of climate changes on LST will be generally minimal at coastal sections in the Gulf of Guinea and the Northern (Mediterranean) whilst relatively higher at sections along the West, and South to East coasts. The implication of this erosion, siltation in harbours and coastal basins trends would be altered which intend would impart for example shoreline management and dredging schemes.

Keywords

Longshore sediment transport, Africa, Climate, CERC

O31.6

Impact of climate change on seasonal erosion and accretion patterns of sandy coast in Africa

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Abstract

The coast is very important providing habitat huge part of the world's population marine ecosystem, marine infrastructure and also essential for tourism. However, coastal erosion is one of challenging issue in coastal zone management because of its devasting impact on the economy and natural systems. The effect of climate change is expected to be critical in coastal areas which may result in change in erosion and sedimentation pattern. This study analyses the impact of climate change on the sediment budget of the coastline of Africa under the various Shared Socio-economic Pathways (SSP 2.6, 4.5 and 8.5) scenarios as prescribed by the Intergovernmental Panel on Climate Change (IPCC). For the purpose of analysis and visualisation, the coastline of Africa was demarcated into 7 regions; the Western Coast, the Gulf of Guinea, Southwest coast, southeast coast, Eastern, Red Sea coast, North coast and Madagascar. The sediment budget for each coastal section (~5 km long) was determined as the difference between the total amount of sediment transported in and out of that section. Basic inputs for the analysis were based on the First Institute of Oceanography-Earth System Model version 2.0 (FIO-ESM v2.0). Analysis showed significant change in the future for all the seasons compared to past. the change was more in the Autumn with a median value of -14.54%, -13.95% and -11.04% and Spring; 31.42%, 29.95% and 28.59% (for the SSP1 26, SSP245 and SSP585 respectively). Summer and Winter periods showed relatively low change in sediment budget. The rate of erosion in Autumn reduces whereas the rate of accretion in Spring increases towards the end of the century. In terms of spatial variation, the Southeast and the Madagascar coast is likely to experience higher rate of erosion whereas the Gulf of Guinea region is expected experience relatively high rate of accretion.

Keywords

climate change , erosion, sediment budget, Africa

O31.7

Downscaling of climate model projections: effects of ocean warming in living organisms in the Rías Baixas

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Abstract

Climate change is expected to have a significant environmental impact affecting primary production and many species with critical ecological and economic effects. As climate change effects will not be the same everywhere, regional studies are necessary to assess the impact of climate change and manage mitigation and adaptation strategies. The Rías Baixas (NW Iberian Peninsula) are four incised valleys located on the northern limit of the Eastern North Atlantic Upwelling system. These rias are areas of high productivity, supporting up to 40% of the European and up to 15% of the world aquaculture production of mussels. Moreover, the rias are acting as contemporary climatic refugia for many habitat-forming macroalgae that provide structure, shelter, and food to many accompanying species that form the ecological community. Numerical models have shown to be one of the best tools to reproduce reality with enough accuracy and to provide data that would be very difficult to obtain through surveys, or even impossible, such as future projections. However, the databases and climate models available have a too coarse spatial resolution to capture detail inside the Rías Baixas adequately. In this study, we use an integrated model, Delft3D_Flow, to perform a downscaling of climate models to study the possible effects of climate change on the mussels productivity and the future geographical distribution of habitat-forming macroalgae. Ocean warming will increase time during which mussels are subjected to water temperature above the maximum value of their optimum growth range. Therefore, it is expected that mussel productivity will decrease. In addition, ocean warming will cause the extinction of macroalgae such as *Himantalia elongata*, and favour the settlement of macroalgae with a higher thermal tolerance limit, as *Bifurcaria Bifurcata*, leading to changes in the ecological community.

Keywords

Numerical model, Downscaling, Climate change, RCP8.5

O32.1

Socio-ecological system dynamics of coral reef ecosystems in Pujada bay along city of Mati, The Philippines

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Abstract

Mati is a typically small underdeveloped town in the Philippines, renowned for the finest beach and abundant natural resources in Pujada Bay(coral, seagrass, dugongs, mangroves). However, Pujada bay is also vulnerable to overexploitation and pollution from land-based activities.". My research aims to predict the future condition of Pujada Bay from socio-ecological perspective in 10 years and provide scientific basis for policy-making based on modeling.

Primary data through survey interviews of local researchers and residents were conducted. Secondary data on related social-ecological systems was done as well from a literature survey. These data would support the System Dynamics Model.

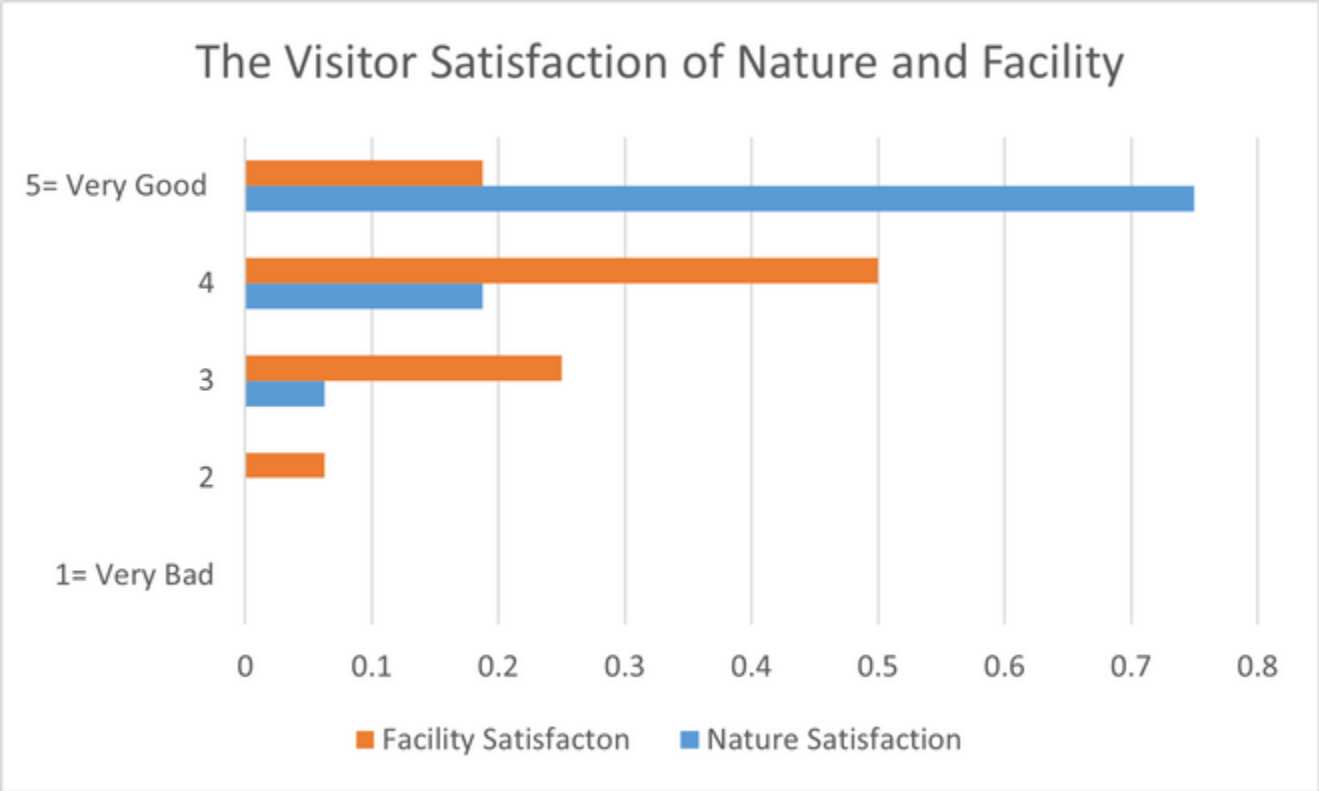

Figure 1 : Visitor Satisfaction

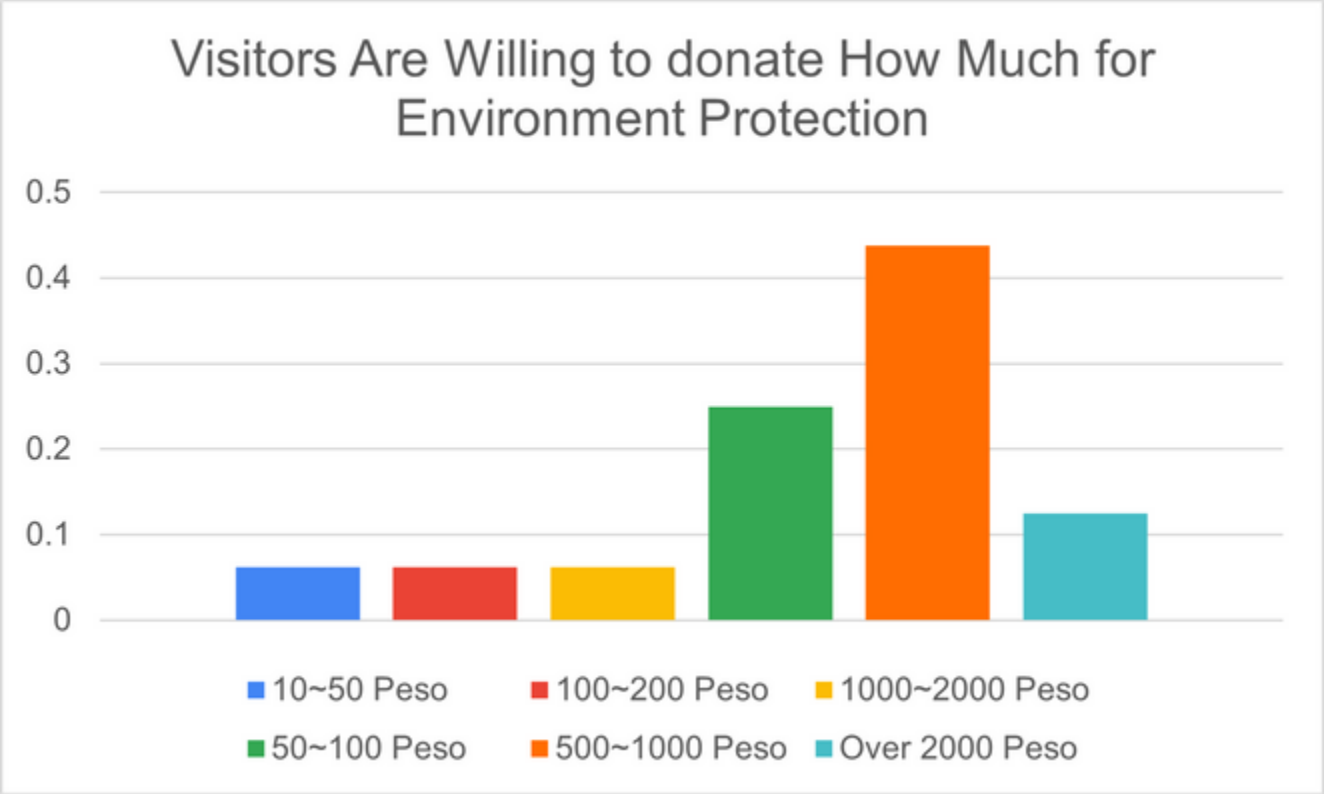

Figure 2 ： Visitor Donation Awareness

Figure 3 ： Travel Cost

This System Dynamics Model completes with Socio-economic, ecological, and environmental subsystems, which variables are closely related with each other both inside and outside the model. It observes integrated coastal zone management theory and is supported by field surveys, questionnaires, and interviews. Components such as coral and algae as an ecosystem, fishery, and tourism as industries, etc. were extracted and their relationships were implemented in the model.

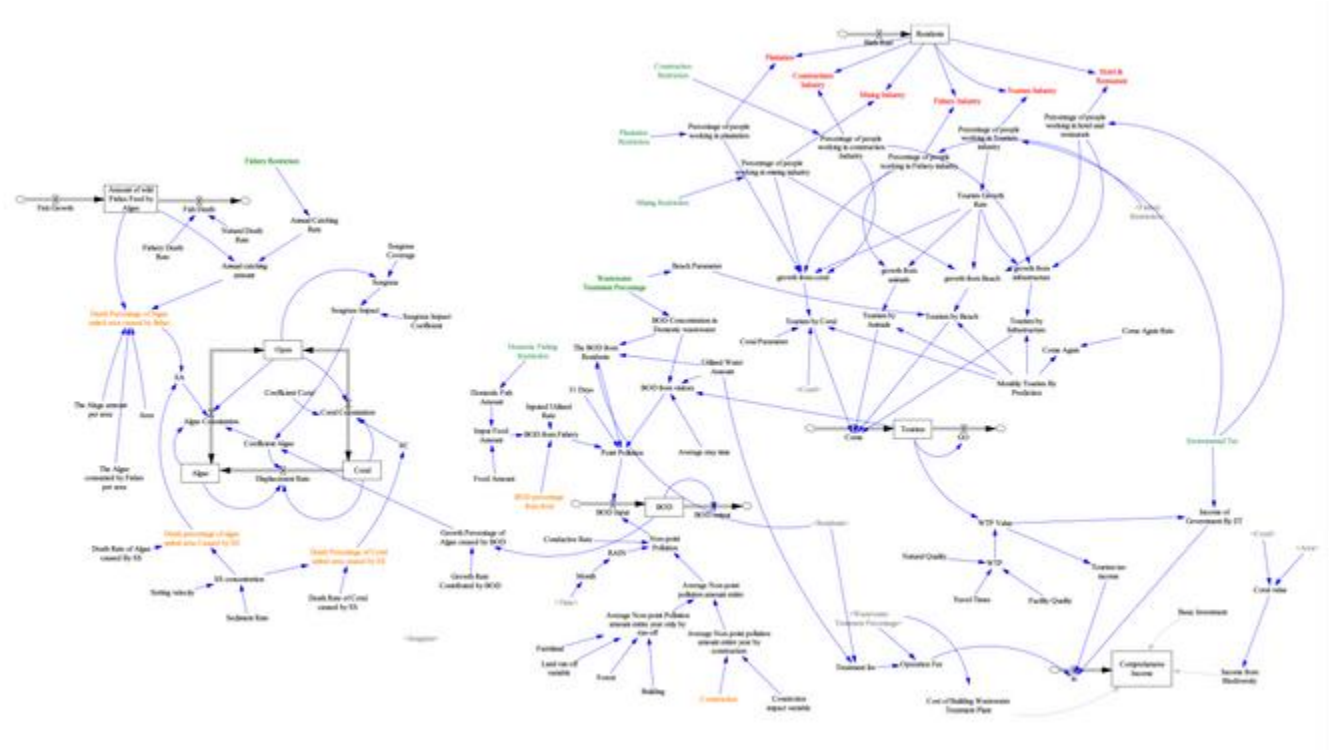

Figure 4 ： Systems Dynamics Model

Coral coverage declination won't reverse if the wastewater treatment rate is low. Besides, Tourists amount is also increased with treatment rate. Comprehensive income, which combines bio-diversity value, tax, wastewater treatment construction, and operation cost, won't be positive if the treatment rate is very high.

The primary influence on ecosystem is seawater quality in Pujada Bay, which indicates by coral coverage. However, combining methods is more efficient in reducing the budget of wastewater treatment.

Natural conditions such as beach sanitation and coral abundance significantly impact Tourism. Domestic visitors are willing to pay about 20% of travel budget ($73) on ecological restoration, which is higher than foreign visitors.

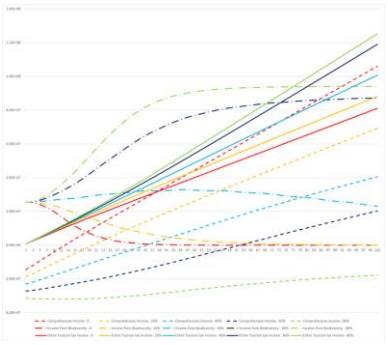

Figure 5 ： Beneficial Analysis Under Different Wastewater Treatment Rate

Keywords

System Dynamics, Socio-ecological System, Coastal Tourism Management, Coral & Algae Ecosystem

O32.2

Fish passage and behaviour through a temporary tidal weir

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Abstract

Tidal weirs are a common solution to prevent saline wedge progression into freshwater systems. However, being in a transitional area between salt and fresh water, they can be severely detrimental for the successful migration of species that are highly dependent on the connectivity between these adjacent systems to complete their life cycle, the diadromous fish. The temporary weir of Rio Novo do Príncipe is a 3-meter-high structure, made from wooden boards and earth, which is annually built in the brackish section of Vouga river, Central Portugal, 2-3 km upstream from Ria de Aveiro Lagoon, a brackish waterbody flowing to the Atlantic. The weir is on place from May to October, to prevent saltwater from reaching upstream freshwater abstraction for industry and agriculture. In 2019, a fishway prototype was added to the weir, and a monitoring program is ongoing to study fish behaviour when reaching and negotiating the passage through this obstacle. This study uses an underwater acoustic camera (ARIS Sonar) to evaluate fish behaviour and movements. Since 2019, monitoring has been conducted weekly or fortnightly during the operation period of the weir (24h periods, 12h downstream + 12h upstream), considering all moon phases and tidal periods. Number of fish (e.g., grey mullets and sand smelts) successfully using the fishway, in each monitoring session, varied between 94 and 1860 in 2019, and 10 and 2357 in 2020, depending on environmental conditions. GLM model showed that variables such as tide level, salinity and moon phase are the main drivers of fish accumulation and movements through the fishway. Compatibilization between saline wedge contention and successful fish migration can be challenging. Results from this study provide insights on fish behaviour when facing obstacles and can help to promote the optimization of fish pass solutions in tidal areas.

Keywords

Tidal barriers, Migratory fish, Fish passage, ARIS sonar

O32.3

Environmental drivers of phytoplankton in a coastal lagoon: exploring the interface between anthropic pressures and ocean processes

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Abstract

Water quality deterioration associated with sewage discharges is of great concern, in particular at high-risk areas such as coastal lagoons. These systems are characterized by shifts in phytoplankton communities that can be exacerbated by increasing eutrophication conditions, and potentially lead to harmful algal bloom development. This study aimed to assess the phytoplankton dynamics in Ria Formosa coastal lagoon at an area influenced by treated wastewater discharges and adjacent coastal waters, and identify underlying environmental determinants. Water samples for analysis of water quality key determinants, and phytoplankton abundance and composition were collected monthly along a gradient of dispersal from the sewage discharge point (up to ca. 2 km), during a 2-year period (September 2018-September 2020). Generalized additive models were used to explore the functional relationships between phytoplankton functional groups and potential environmental predictors. Overall, salinity increased with distance from the discharge point, while temperature, nutrients, suspended solids, chlorophyll-a, cyanobacteria, euglenophytes and planktonic diatoms declined, suggesting an influence of the sewage discharge up to 1500 m from the source. Phytoplankton included several potentially toxigenic taxa, and were dominated by cryptophytes and planktonic diatoms, that usually showed spring-summer maxima. Maximum phytoplankton biomass, dominated by diatoms, was detected during July 2019, down to 750 m from the discharge point, associated with extreme minimum of silicate and maxima of pH and dissolved oxygen. For the furthest stations, a higher influence of coastal processes was detected. For these stations, the impact of upwelling events will be specifically explored.

Keywords

phytoplankton variability, wastewater impacts, ocean interface, coastal lagoon

O32.4

Meagre (Argyrosomus regius) movements between and within an important nursery and spawning area

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Abstract

The meagre (*Argyrosomus regius*, Asso 1801) is a long-lived commercially and recreationally important marine fish. The species forms ephemeral spawning aggregations that exacerbate the risk of overexploitation. Across the species distribution range in the Northeast Atlantic, Central Eastern Atlantic and Mediterranean, only five spawning areas are identified. The Tagus estuary (Portugal) is one of these areas. The estuary and adjacent coastal area congregate approximately two thirds of Portuguese meagre catch and constitute the main fishing area of the Iberian Peninsula. We aim to unravel the migratory movements of the meagre through an interdisciplinary approach combining tagging, natural markers, and bioacoustics, focusing on the use of the Tagus estuary as nursery and spawning area. We are using acoustic biotelemetry to obtain fine-scale information on habitat use within the estuary, but also on the movements to adjacent coastal areas and other estuarine systems. This will be achieved with MIGRACORV project arrays and CoastNet infrastructure (Portuguese Tracking Network). This infrastructure includes arrays of acoustic receivers throughout the coast and the estuarine systems where the meagre is known to occur in Portugal. Acoustic receivers deployed in the Tagus estuary have already provided information on the movements of three adults and twenty-four juveniles between 2019 and 2020. Two of the adults tagged in 2019, revisited the estuary one year later during spring and summer. Juvenile residency in the estuary appears to be longer, and some of the specimens have been detected through the autumn and winter, while others visited the estuary in consecutive years. In total, we aim to tag 50 juveniles and 25 adults. Acoustic tagging and our multi-faceted approach is expected to resolve the life history movements of meagre, provide the grounds for active and corrective management of the meagre fisheries and highlight alternative solutions for fisheries of other estuarine/coastal-dependent fisheries resources.

Keywords

Acoustic telemetry, Tagus estuary, Fisheries management, Habitat use

O33.1

What ecological and functional changes follow the positioning of an artificial barrier? Answers from a 4-years investigation on soft-bottom benthic community

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Abstract

Nowadays, the consequences of shifts in species composition for marine ecosystem functioning due to human pressure are largely unknown. In this study, we assessed the variation of taxonomic and functional diversity (i.e. range of species and their biological traits), and functional identity (i.e. the occurrence of certain traits) in soft-bottom macrofaunal community influenced by the construction of the coastal artificial barrier in north-eastern Sicily (Tyrrhenian Sea). The macrofaunal invertebrates were collected in five transects around the barriers during four years that encompassed the following phases: *ante-operam* (2003), *in-operam* (2004-2005), and *post-operam* (2006). The biological traits analysis was performed considering 10 biological traits, gathered in: life strategies, adult feeding habits, movement methods, and response to anthropogenic stress. The influence of *rip-rap* construction on the macrofaunal community was clearly observed during *in-operam* and *post-operam* phases. Overall, the macrofaunal community displayed a shift in species composition towards the end of the study. In fact, higher values of turnover diversity were noticed in 2006 (β_t=0.80±0.145). However, this variation was not mirrored in the functional diversity index, since no significant differences among years were obtained (Fdisp=0.15±0.04). Further, we observed a great variation in occurrences between traits as 'response to anthropogenic stress' and 'colonizer'. In fact, we noticed a dominance of *second colonizer* and *sensitive* invertebrates in 2003, whereas *tolerant* and *pioneer species* occurred in 2006. Our results indicate that during the construction phases the community taxonomic composition changed through species replacements and/or new settlements, yet the ecological functions performed by the anthropogenically-altered community remained the same.

Keywords

soft-bottom macrofauna, Beta-diversity, Functional traits, Artificial barriers

O33.2

What do benthic macrofauna tell us about the environmental state of marine and tourist ports?

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Abstract

In semi-enclosed basins, such as ports, the effects of point source and synergistic forms of contamination are emphasized. The effects of human pressure on benthic macrofaunal assemblages inhabiting marinas and tourist ports have been seldom studied, especially in the western part of the Adriatic Sea. In the framework of the project ECOMAP, in July 2019, we investigated the macrofaunal communities in two tourist ports, namely Spinut and Podstrana (Croatia). The macrofaunal abundance, diversity indices and species composition were used to evaluate the ecological status of both marinas. In each marina, sediments were sampled at five stations positioned considering the morphology of the basins (i.e. confinement gradient) and the surrounding human activities (shipyard and boathouse areas). The macrofaunal features were related to sediment physical-chemical variables (grain-size, Organic Carbon-OC, Total Nitrogen –TN and heavy metals). Both marinas were characterized by muddy sediments in their inner part, and higher sand contents at the main port entrances. Sediments in Podstrana displayed slightly higher contents of OC compared to Spinut (12.8±6.6 and 11.2±2.9 mgC g^{-1}, respectively). In both marinas we observed higher diversity at the main entrances than at the inner sites. Overall, the macrofaunal communities were characterized by the dominance of marine/estuarine species (e.g the polychaete *Heteromastus filiformis* and the bivalve *Abra prismatica*). In Spinut, we observed an impoverished community nearby the boathouse area. In fact, this long-lasting activity deeply modified the sediment characteristics (we observed e.g. pieces of antifouling coating), leading to poor environmental conditions. This study indicates that the inclusion of macrofaunal community features in monitoring plans could help local managers of ports and marinas design site-specific environmental interventions to mitigate anthropogenic disturbances.

Keywords

macrofauna, tourist ports, human pressure, biodiversity

O33.3

Diversity and functioning of harbor communities - Studying small-scale spatial variability on different levels of biological organisation.

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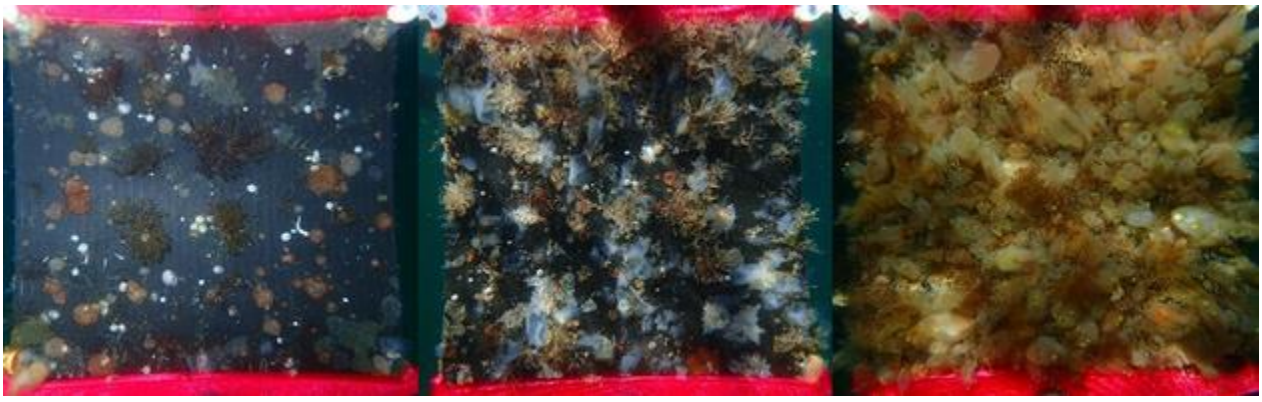
Abstract

Urbanization of coastal habitats, often exemplified by harbors and marinas, has led to various ecological paradigms, questioning the functioning of these new semi-enclosed ecosystems. While destroying natural habitats, harbor infrastructures offer new substrates that are colonized by a wide array of organisms (biofouling). They are, however, no substitute to natural ecosystems since environmental filters and key ecological processes may differ, their biotic composition differs from natural habitats, and they are characterized by high diversity and abundance, or even dominance of introduced species. These still poorly understood environments are profoundly impacted by human disturbances that are often intense but localized, resulting in environments characterized by strong gradients or patchy conditions which constitute strong selection filters. Our study aims to understand how these environmental filters impact living organisms in harbors on a very small spatial scale (< 100 m). We seek to understand which abiotic factors (pollution, etc.) vary on this small scale and how these filters impact the community as a whole as well as the molecular composition of certain key species via metabolomic analyses. The observations indicate a strong variability of communities, likely impacted by environmental filters, but also changes in the metabolome in some key species in these ecosystems.



O33.4

Responses of soft-bottom bacterial diversity and processes to short-term oxygen depletion and recovery: insights from a manipulation experiments in the Venice lagoon

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Abstract

Dissolved oxygen depletion (hypoxia/anoxia) in sediments and bottom waters are becoming increasingly common in coastal marine systems, either because of increased nutrient inputs, leading to higher rates of algal production and oxygen consumption, or due to changes in ocean circulation patterns (wind regime and upwelling). Hypoxia/anoxia are threatening biodiversity and associated processes in transitional water ecosystems. Specifically, oxygen availability affects microbial functional diversity and activities, which in turn regulate biogeochemical processes. Therefore, investigating the response of ecosystems to hypoxia/anoxia is important to understand and predict the stability of ecosystems functioning. Microbial communities can take advantage of benthic vegetation (e.g. through oxygen transport and release from roots) and their response to hypoxia/anoxia is expected to change with sediment colonization by different primary producers. To test these hypotheses, oxygen depletion was experimentally induced in sediments of the Venice lagoon (Italy) by prolonged dark incubation (60 hrs) of sediment cores with different primary producer (microphytobenthos, macroalgae, seaweeds). Normoxic conditions were then re-established. Features of the bacterial community and benthic processes were investigated before, during the anoxia, and after re-oxygenation (24 hrs). Biochemical composition of sediment organic matter, functional proxies (prokaryotic C production and extracellular enzymatic activities), diversity of the total and active bacterial communities (16S-RNA tag-sequencing of DNA and cDNA) and net fluxes of O_2, CO_2, N_2, NO_3^-, NH_4^+, PO_4^{3-} were measured at the water-sediment interface. The outcomes of the experiment highlighted clear differential responses of microbial functioning, evident through an increase in mineralization and evidenced a fast recovery to normoxic conditions in both vegetated and non-vegetated sediments. The analyses of microbial diversity on the active portion of the microbial community during oxygen depletion and restoration of normoxic conditions are here discussed to further elucidate the effect of oxygen deficiency events on sediment biogeochemistry and rates of recovery after such events.

Keywords

oxygen depletion, coastal sediments, bacterial diversity, microbial processes

O33.5

Seasonal stratification and biogeochemical turnover in the limnic reach of a partially mixed dredged estuary

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Abstract

The Elbe estuary is a substantially engineered tidal water body that receives high loads of organic matter from the eutrophied Elbe river. The organic matter entering the estuary at the tidal weir is dominated by diatom populations that collapse in the deepened freshwater reach. Although the estuary's freshwater reach is considered to be well-mixed, several indicators like trapping of particulate organic matter, near-bottom oxygen depletion and ammonium accumulation suggest that the vertical exchange of organic particles and dissolved oxygen is weakened at least temporarily. To better understand the causal links between the hydrodynamics and the oxygen and nutrient cycling in the deepened freshwater reach of the Elbe estuary, we establish a three-dimensional coupled hydrodynamical-biogeochemical model. The model demonstrates good skill in simulating the variability of the physical and biogeochemical parameters n the focal area. Coupled simulations reveal that this region is a hotspot of the degradation of diatoms, heterotrophs and organic matter transported from the shallow productive upper estuary and the tidal weir. In summer, the water column weakly stratifies when at the bathymetric jump warmer water from the shallow upper estuary spreads over the colder water of the deepened mid reaches. Enhanced thermal stratification also occurs also in the narrow port basins and channels. Model results show intensification of the particle trapping due to the thermal gradients. The stratification also reduces the oxygenation of the near-bottom region and sedimentary layer inducing oxygen depletion and accumulation of ammonium. The study highlights that the vertical resolution is important for the understanding and simulation of estuarine ecological processes because even weak stratification impacts the cycling of nutrients via modulation of the vertical mixing of oxygen, particularly in deepened navigation channels and port areas.

Keywords

Tidal pumping, stratification, Hypoxia, eutrophication

O34.1

Profiling microplastic pollution in mangrove dominated estuaries of the Eastern Cape region in South Africa.

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Abstract

Microplastic (MP) pollution is a global environmental threat. A wide variety of plastic spheres, differing physically and chemically, have been detected in all major marine environments and various marine fauna. Baseline levels of MP pollution in many biodiverse ecosystems and geographical regions have not yet been established and this is particularly true for Africa. This is worrying since countries like South Africa rank highly in terms of marine plastic pollution globally. Furthermore, recent reports suggests that these ecosystems are sinks for plastic pollution. This study forms part of the first comprehensive assessment of MP pollution in mangrove-dominated estuarine systems in South Africa, providing some of the first data on estuarine MP levels in the Eastern Cape region. The study aimed to quantify the density, typology (size, morphotype, colour, level and chemical composition) and distribution of microplastics in relation to selected disturbances acting on these systems. Sediment samples were collected within three intertidal zones (at varying distances from the main channel) in four mangrove-dominated estuaries. Surface water samples were collected at the mouth of each estuary. Preliminary results suggest potential differences in MP profiles between urban and rural systems; urban systems had higher MP levels (~ 70% more) in both sediment and surface water. For this study microfibers dominated in sediment and surface water. The results are in agreement with recent studies which have reported higher levels of MPs in anthropogenically disturbed estuaries and the dominance of fibres. This study, therefore, supports a growing opinion that mangroves represent MP sinks. The ultimate goal of the study is to both understand and communicate the implications of MP pollution in this ecosystem to encourage land use and waste management practices that reduce plastic pollution inputs into them.

Keywords

Plastics, Mangrove, Estuaries, South Africa

O34.2

Are microplastics detected in the bogue *Boops boops* (L.) reflecting those available in its coastal feeding grounds?

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Abstract

Understanding the exposure of marine fish to microplastics (MP) has been largely addressed through the monitoring of MP extracted from gastrointestinal tract (GIT). Such studies report that MP ingestion varies considerably among species, depending on the habitats occupied and proximity to sources of pollution, but also on their feeding habits and time of the year. However, a comparison between MP ingested by fish and MP available at their feeding grounds, has seldomly been performed.

This study aims to address the highlighted gap by detecting and comparing temporal patterns in MP extracted from both seawater surface and sediment samples collected monthly (from Oct 2018 to Feb 2019), at nearshore stations along the Sado river estuary and the Professor Luiz Saldanha Marine Park, with MP ingested by wild adult fish of a commercial species (*Boops boops*) caught concurrently in the same marine area.

The percentage of fish with at least 1 MP in the GIT, among the 50 replicates collected each month, decreased from October (75%) to February (50%). The mean of extracted MP was 1.82 ± 1.37 items per fish (mean ± SD), ranging between 1 to 11 items per fish. Mean particle size was 1306.77 µm, being 44.48 µm the smallest. Although the bogue is an opportunistic omnivore, feeding on benthic and pelagic prey, the patterns verified in MP ingested by this species revealed more similarities with MP extracted from sediment samples. Besides presenting the same predominant types, namely blue fibers and filaments, the temporal fluctuations of MP abundance matched, being higher in the autumn months. This contrasts with the higher abundances verified during winter in surface samples, where fragments prevailed.

Detecting such relations for this coastal species highlights fish vulnerability to plastic pollution and their potential to be used as a proxy of the local MP pollution level.

Keywords

microplastics, ingestion, Boops boops, temporal patterns

O34.3

Control of Plastics from Coastal Watersheds - Benefits of Regulation Under the U.S. Clean Water Act

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Abstract

Waterborne debris, including plastics and micro-plastics is a world-wide problem that is growing rapidly. Plastic debris is accumulating in all of the world's oceans in gyres resulting from natural ocean currents and is having profound effects on ecosystem and human health. It has been estimated that 80% of the debris is coming from runoff from the land. In some parts of the U.S., waterborne trash from coastal watersheds is being classified as a pollutant and is being regulated under provisions of the federal Clean Water Act. The US States of California and Maryland and the District of Columbia have developed regulatory limits to control the flow of plastics and other debris using the Total Maximum Daily Load (TMDL) section of the Clean Water Act. TMDLs have been in force in Los Angeles, California, Washington, D.C. and Baltimore, Maryland for several years now and the affected cities and surrounding county governments have been required to developed debris control plans and take various actions such as: installation of debris collection devices to capture trash within public storm system; enhance mechanical street sweeping, preventive stormdrain inlet cleaning, and routine waterway cleaning; and encourage litter reduction and increased recycling. A very visible and popular example in Baltimore's debris collection effort is the Water Wheel Trash Interceptor -- "Mr. Trash Wheel". The large amount and types of trash collected by the wheel and reported to the public provides valuable information that is being used to help focus trash intervention actions in Baltimore. This presentation will cover ongoing trash reduction efforts in these three cities and recommended actions that can be widely implemented to address trash and marine debris and quantitatively document progress on controlling water-borne debris that may be valuable to many other cities that are beginning to address this significant global issue.

Keywords

Plastic pollution, regulation of plastic debris, Clean Water Act, Chesapeake Bay

O34.4

ENGAGE for Research Planning and Capacity Development: Fostering SDGs 14 and 17 for Integrated Coastal Zone Management (ICZM) in Southeast Asia

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Abstract

Transforming our world, the 2030 Agenda for Sustainable Development - a global plan of action for people, planet and prosperity launched in 2015 – outlined 17 Sustainable Development Goals (SDGs) and 169 targets to integrate the three dimensions of sustainable development: economic, social and environmental. The focus on coastal systems is represented by SDG 14- to conserve and sustainably use the oceans, and marine resources; and SDG 17- to strengthen the global partnership for sustainable development is an overarching mandate towards the implementation of the 2030 Agenda. Within this context, The Sustainable Management and Governance of Coastal Ecosystems (ENGAGE) project was conceived. The ensuing synthesis presents highlights of the ENGAGE project from its inception in 2016 to its 'impact mapping' to March 2020. In 2016, the joint program implemented by AIT-Vietnam and UNU-INWEH as the key partners. The overarching objective of the program is to share an innovative and collaborative approach for research planning and capacity development towards Integrated Coastal Zone Management (ICZM) by employing a training-cum-workshop (Tcw) model. The goal was to steer long-term engagement of regional experts, create an enabling platform for information and knowledge exchange in the region, connecting researchers, development workers, and government officials working in coastal regions, along with policymakers, community leaders and resource managers. The Tcw model provided a face-to-face opportunity for a multi-stakeholder dialogue workshop held in Vietnam with 31 participants from 6 countries. Alongside, a virtual networking space through Facebook was established in 2017 to facilitate information sharing to design collaborative work. The group has > 500 members, with a significant proportion of early-career researchers. The ENGAGE program fosters capacity development and creates an enabling environment for regional stakeholders to collaborate in ICZM. National researchers share designed programs based on experiences gained through the ENGAGE network, of which a few key impacts and milestones will be presented.

Keywords

ENGAGE, Coastal Ecosystem Management, ICZM, EBA

O34.5

Quantifying coastal biodiversity change across continental scales: a case-study comparison of European and South African shores

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Abstract

Multiple scales of anthropogenic effects have been observed along modern coastlines and these have been linked to patterns of recent biodiversity change. However, the metrics used to monitor this change are not always fully representative of functional compositional shifts in communities. For example, standard measures such as diversity or richness can theoretically remain unchanged between two time intervals even if the community composition altered substantially. In this study we compared long-term monitored examples (≥ 5 years) of coastal biodiversity data between two disparate marine regions: the North Sea (Germany) and the South African coast. We applied a new method of assessing biodiversity change which specifically accounts for compositional turnover rates (Hillebrand et al. 2017 *Journal of Applied Ecology*). Results suggested that there was little change in univariate measures of diversity and richness for both regions. In contrast, the turnover metrics showed that the communities were reworked on average to a 30% compositional change. Geographical similarities in terms of accumulation rates of turnover over time were also apparent. This suggests that community turnover metrics are a better representation of biodiversity change than conventional indices, and that this reasoning can be applied across broad spatial scales. A secondary outcome of this study highlighted the need and value of long-term coastal biodiversity monitoring data to accurately quantify change. This research will appear in *Philosophical Transactions of the Royal Society B: Biological Sciences*.

Keywords

species turnover, termporal trends, long-term monitoring, coastal biodiversity

O34.6

Creation of an indicator for monitoring the ecological quality of a site in a context of coastal realignment

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Abstract

The ADAPTO project is a 4-year Life project currently taking place in France, exploring adaptative solutions to mitigate the impacts of climate change on the French coastlines from an ecological, economic and social point of view. Among the ADAPTO pilot sites, several were chosen to experiment coastal realignment, a process involving the flooding of a previously impounded land by an accidental or a managed change in coastal protection (typically, dyke).

In this context, an indicator monitoring the ecological quality of the sites is being developed, in order to assess the effects of coastal realignment on biodiversity. This indicator meets several expectations: (i) take into account the notions of composition, heritage, structure and functionality; (ii) be usable by site managers who do not necessarily have in-depth naturalist or technical knowledge and who do not always have access to accurate and costly data; (iii) and be demonstrative and educational in order to be used as a communication tool with the public to raise awareness of the issues involved in realignment. To meet these demands, a habitat-based approach has been deployed. A habitat map, obtained by field work or remote sensing, is coupled with an ecological capacity matrix, resulting in a radar diagram evaluating the site ecological quality at a time t.

The habitat map can also be combined with a submersion map realized for different realignment scenarii, in order to predict potential future habitats. The application of the indicator then allows to evaluate and compare the scenarii from the biodiversity point of view.

Keywords

Coastal realignment, Biodiversity, Indicator, Remote sensing

O35.1

Hydrodynamic models ensemble to forecast future estuarine circulation and morphological patterns

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Abstract

Numerical models are essential tools to simulate the hydro-morphodynamics of estuarine systems, allowing a better understanding of these systems and the anticipation and prediction of the effects of anthropogenic interventions, extreme events and climatic change impacts, and providing the basis for efficient management tools. However, as model results present uncertainties, mainly related to inaccuracies or assumptions in the initial and forcing conditions, we need to increase the forecasts accuracy by developing and implementing new solutions that avoid or mitigate such errors. The EsCo-Ensembles project proposes the application of the ensembles technique to improve the hydro-morphodynamic patterns forecasts in estuaries. Two numerical models, openTELEMAC-MASCARET and Delft3D, are considered to simulate current and future states of two of the most important estuaries on the Northern Portuguese coast: the Douro and Minho estuaries.

Preliminary simulations considering extreme sea level conditions, under different climate change scenarios, demonstrate an aggravation of the associated flood level in the Douro estuary also due to the recent evolution of the sand spit located at the estuary mouth. Given that this estuary is strongly dominated by the freshwater flow, the effect of the rising sea is hardly noticeable during flood events. On the contrary, the Minho estuary, dominated by the tide and therefore by oceanographic conditions, shows a more pronounced effect of sea level rise.

The final results of this project are expected to demonstrate that the combined use of different models reduces their uncertainty increasing the confidence and consistency of the forecasts. These results will contribute to: (i) provide a complete hydro-morphodynamic characterization of the two estuaries; (ii) evaluate future trends; (iii) understand the distribution of the biota and the functioning of ecosystems; and (iv) estimate the flood risks associated with extreme events.

Keywords

Estuaries, Morpho-hydrodynamics, Numerical models, Extreme events and climatic change

O35.2

Tidal bedforms dynamics, Weser Estuary, Germany

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Abstract

The distribution, morphology and dynamics of tidal bedforms in the Weser Estuary, Germany, between the tidal limit (river-km 0 at the tidal weir in Bremen) and the open North Sea (river-km 111 in the Outer Weser) was analysed for a three-year period based on monthly bathymetric surveys carried out along the main waterway. Bedforms were detected from gridded bathymetry data and their geometric properties described. In particular, the presence and position of a slip face, defined as the portion of the lee side steeper than 15°, was recorded as a simplified indicator of bedform roughness.

Bedforms were present along most of the estuary channel, apart from a section between river-km 55 and 75. There, muddy cohesive sediment hindered the formation of bedforms. Along the channel and throughout the years, bedform lengths varied between 20 and 60 m and heights between 0.3 and 1.6 m.

During times of high fluvial discharge, in winter and spring, bedforms were generally small, long and ebb-oriented (i.e. the ebb lee side was shorter than the flood lee side). Many bedforms featured an ebb slip face but no flood slip face. This suggests that bedforms were active roughness elements during the ebb phase only.

In summer and autumn, when the discharge was low, bedforms in the upper reach (ca. river-km 15 to 30) gradually became flood-oriented and many bedforms there developed a flood slip face, implying that the bedforms were active roughness elements during the flood. Between km 30 and 55, bedforms were predominantly ebb-oriented, and many bedforms had an ebb slip face but only few had a flood slip face, so bedforms were only active during the ebb phase.

The annual variations of bedform dimensions and shapes reveal an intricate feedback between river and tidal flows, channel morphology, sediment dynamics and bedforms.

Keywords

Bedforms, Estuary, Sediment dynamics

O35.3

Very severe storm tides and their effects in the Ems and Elbe estuaries.

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Abstract

Storm tides present one of the major natural hazards for the German North Sea coasts. For the estuaries, the storm high water can be aggravated by high river discharge leading to additional thread for the low-lying areas. Information about very severe and rare events is important for planning and management of coastal protection and infrastructure. The research project EXTREMENESS “Extreme North Sea storm surges and their consequences” focuses on extreme events which are highly unlikely but physically plausible and which may have significant impact. Observational data provide a limited amount on information on such events. Here, a comprehensive dataset of modeled water levels and corresponding atmospheric conditions from reconstructions and climate projections was analyzed and several very severe storm tide events were identified. Possible amplification mechanisms such as different constellations of atmospheric conditions and tides but also combination of such events with increased mean sea level and high river discharge were investigated with medium and high resolution hydrodynamic models. It is argued that the unprecedented high water events can occur already under the present-day conditions and their probability can experience changes related to the climate change in the future. The focus region of the study was the East Frisian North Sea coast, the Ems estuary and the town Emden. As severe storm events can affect the German estuaries differently, the results for the Ems estuary were compared to those for the Elbe estuary.

Keywords

storm tide, Ems estuary, extremes

O35.4

Towards improving model schematisations for the burial of fines within a sandy seabed

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Abstract

Fine sediments play an important role in the ecological functioning of coastal ecosystems, even when the seabed is predominantly sandy. Once fines are mobilized from the seabed, for instance by human activities, turbidity increases. The associated negative effects on both pelagic and benthic fauna are often estimated by using sediment transport models. These models are hampered by limited knowledge on the fluxes of fines into and from the seabed, which largely determine the affected area and residence time of fines. It is hypothesized migration of small-scale bedforms governs the burial of fines, i.e., the flux into the seabed.

To study this, we developed a conceptual model describing the temporal development of bed elevation as a function of near-bed hydrodynamics. Furthermore, the model estimates the location and mass of buried fines by linking deposition of fines to local sedimentation of sand. We validated this model with data collected during two field campaigns, situated nearshore of Egmond aan Zee, the Netherlands. As inputs for the model, we measured near-bed hydrodynamics using instrumented landers. Bed elevation was measured with multibeam echosounding, sidescan sonar and a small-scale ripple profiling sonar. Upper seabed structure was assessed by combining seabed sediment sampling with sediment profiling imagery.

The model shows that flattening of storm-induced megaripples by current-induced ripples is the dominant process for burial of fines within a sandy seabed. This process leads to a large horizontal variability in the presence of fines, with fines percentages varying an order of magnitude within meters. Model outcome agrees qualitatively with observations of upper seabed structure.

We identified the governing physical process for burial of fines in a sandy seabed and validated this with measured field data. As small-scale variability is inherent to this process, this should be explicitly accounted for in model schematisations of the seabed.

Keywords

fine sediment, North Sea, sediment transport, modelling

O35.5

The influence of the estuarine circulation on estuarine sand dune formation: an idealized modeling approach

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Abstract

In many estuaries, sand dunes can be found; these are large-scale rhythmic bedforms. They have wavelengths on the order of tens to hundreds of meters, and heights of up to one-third of the water depth. An observational study in the Gironde Estuary, France, showed that sand dunes may migrate upstream – against the river flow (Berné et al., 1993). Our aim is to explain the influence of estuarine circulation on this phenomenon.

To this end, we develop an idealized process-based model which captures the motion of water and sediment within a local section of a generic estuary. The schematized nature of idealized models makes them computationally cheap, and allows for qualitative physical insights. Our model includes, in addition to tidal and river flow, a horizontal baroclinic pressure gradient (leading to gravitational circulation) and time-dependent eddy viscosity which follows from stratification (and which also induces circulation). We do so by imposing the along-estuarine salinity gradient and time dependence of the eddy viscosity (i.e. a diagnostic approach).

The model results provide generic insights into the influence of estuarine circulation on bedform dimensions and dynamics. In particular, they reveal the dominant wavelength and the corresponding growth and migration rates. The migration rate is directed opposite to the river discharge for a portion of the parameter space – part of which is representative for the Gironde estuary. The presented study is a first attempted to quantify the effect of estuarine circulation on sand dune dynamics, thus contributing to our knowledge of estuarine morphodynamics.

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Keywords

Estuarine sand dunes, Morphodynamic modeling, Estuarine circulation

O35.6

Assessing freshwater storage in coastal estuaries: A case study of Brisbane river estuary and Moreton bay Australia

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Abstract

Water scarcity has become a serious issue in the coastal area due to rapid economic activities. This study proposes CR as a viable water development solution for Brisbane, Australia coastal areas to fulfill growing water demand. MIKE 21 FM, hydrodynamic module (HD) coupled with the transport module (TR) was used to simulate water quality by analyzing the longitudinal salinity distribution and flushing time. The 2D hydrodynamic model was calibrated and validated for the 2008 and 2011 flow events respectively, by using field observations of flow and salinity data. This study provides the complete salinity distribution and water quality analysis under different flow conditions in the Brisbane River estuary (BRE). Results show that when total river flow into the estuary is greater than 150 m^3 s−1, then CR could considerably store water during high flow and low salinity time. These results indicate that the optimum value of flows needs to be at least for 302 hours in the estuary to flush the salinity at the estuary mouth and to allow the freshwater inside CR. This study indicates that the common analyses that the estuaries cannot provide freshwater are not correct, instead intermittent fresh water at the estuary mouth can be diverted to CR while carefully regulating the salinity through intake gates. This study is of interest to salinity and flushing management in estuaries and could provide useful information on water management for the coastal community.

Keywords

Water quality, Coastal Reservoir, , Numerical Modelling

O35.7

Flow resistance features in small tidal estuaries of the White Sea

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Abstract

The Saint Venant equations offer the mathematical base for the most 1D software aimed for non-steady simulation in various environments including tidal estuaries. It is usually accepted that a flow resistance under unsteady regime is approximately equal to a resistance of steady flow in a channel of the same geometry and roughness, and a friction slope could be expressed like a geometric slope in Chezy or Darcy–Weisbach equations. Variations of the resistance in unsteady flows are studied deficiently, they are assumed to be related with changing structure of turbulent currents, flow pulsation effects, streamwise energy gradients, and transformation of velocity vertical profiles.

In order to investigate flow resistance and other hydrodynamic features of the reverse currents during the tidal cycle detailed field measurements were undertaken in small estuaries of the White Sea. The spring tide ranges from 2 m at mouths of the Kyanda and Tamitsa to 9 m at the Syomzha estuary and the tidal flow significantly exceed the river runoff at low water season. The method of field research was based on the simultaneous registration of water level by barometric loggers and discharge measurements by ADCP in cross-sections located in different distance from the mouth. The obtained data allowed the direct calculation of the momentum equation terms and evaluation of their changing during the tidal cycle.

It was discovered that the hydraulic resistance varies in wide range and under some conditions even drop below the zero just after the slack water. This phenomenon could be linked with the nature of eddy viscosity and the mechanism of energy dissipation in turbulent flows as the case of reversed energy transfer from turbulent pulsations to the mean flow.

The reported study was funded by RFBR, project number 19-35-90032.

Keywords

reverse currents, tydal cycle, flow measurements, energy dissipation

O36.1

Metal pollution management in the coastal sea of Ulsan, Korea

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Abstract

This study shows the main elements of the marine heavy-metal pollution management system in Ulsan, Korea and how the Ministry of Oceans and Fisheries (MOF) and the Ulsan Metropolitan City endeavored to improve the marine environment of the area. The governmental research program of the area started in 2014 and the first basic plan and the action plan were formulated in 2018. This study is based on the two plans and annual reports of the research project by the Korea Maritime Institute and other research institutions involved. The Ulsan program consists of scientific monitoring and modelling, analyses of watershed area's pollution load and sources, and meetings of a scientific advisory committee and a stakeholders' council. After preliminary survey in the early years, the program chose to focus on Onsan area and three metal elements, copper, zinc and mercury, in the sea-bottom sediments. Target concentration of each pollutant in the surface sediments were set considering Korea's official Marine Environmental Standards. The program is in its first phase (5 years) and it still has many problems and weak aspects. Yet, it is the first approach by the Korean government to deal with metal pollution of the coastal seas in scientific and systematic ways by preventing land-based pollutants form reaching the sea.

Keywords

marine environment, marine metal pollution, marine environmental policy, environmental governance

O36.2

‘Many a mickle makes a muckle’: considering cumulative stressors on marine mammals

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Abstract

The effects of human activity can lead to multiple stressors having a cumulative impact on the environment. Cumulative Effects Assessments (CEA) formally evaluate these impacts, yet are a recognised area of significant weakness despite being an integral component of the Environmental Impact Assessment (EIA) process since its inception in 1985. This is in part because our knowledge of the consequences of anthropogenic impacts, and the associated thresholds, varies broadly, and our understanding of how stressors may interact is limited. As such, CEAs usually assess the impacts of each stressor separately, though it is evident that considering stressors individually or in isolation does not indeed constitute a true assessment of their cumulative effects.

We present the results of a review of >70 CEAs from ten maritime industries considering potential cumulative impacts on marine mammals. Using an objective framework to examine the quality of each assessment allowed for comparison over time and across industries. We found inconsistency in the language used to define and describe cumulative effects, a lack of routinely applied methodology, and an overall disparity in CEA quality across industries. There was no explicit description of the temporal or spatial scale of the assessment in 67% and 41% of cases, respectively, despite defining scale being a critical component of an effective CEA. Furthermore, for over three-quarters of the CEAs the decision provided on whether impacts were predicted to be significant (and so requiring appropriate mitigation measures to be taken) was based on the practitioner opinion rather than quantitative analysis. This raises uncertainty about the effectiveness of these assessments as a replicable tool to quantify and ultimately prevent significant cumulative impacts occurring. We assessed CEAs where marine mammals were receptors due to our collective expertise, however our findings are broadly applicable to CEAs conducted for marine environments.

Keywords

marine mammals, cumulative effects, impacts, practice

O36.3

Learning from successful management measures in recovering the ecological quality status of estuaries and coasts, based on long-term data

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Abstract

Monitoring and assessment of physico-chemical, chemical and biological (phytoplankton, macroalgae, macroinvertebrates and fish) elements, started in the Basque Country (N Spain) estuaries and coast in 1995. This monitoring network from the Basque Water Agency, has been handled by AZTI from the beginning, producing an important set of data, which has been used to develop different ecological and chemical assessment tools. Most of these tools have been applied within the European Water Framework Directive, and have served to test and monitor the response of the marine ecosystem components to both different human pressures (degradation) and management measures taken to reduce those pressures (recovery). From the long-term series available (1995-2020), trends in the recovery of the marine systems and their ecological status are identifiable. From the study of that set of data, several lessons emerge, that can be used in other locations as viable solutions to achieve good ecological status.

Keywords

monitoring, assessment, ecosystems recovery, long-term series

O36.4

Assessing oil spill risks in transboundary areas: the importance of science - policy dialogue.

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Abstract

The overall increase in maritime transport, coastal urbanization and the foreseen increase in offshore oil and gas extraction pose serious risks of pollution from hazardous substances for several coastal states and, in particular, in marginal and land surrounded seas. Those seas are often shared by more countries, and therefore a common approach to environmental monitoring and good environmental status achievement and maintenance are recommended to guarantee the protection of the marine environment and allow sustainable development. Within the Mediterranean Sea, the Adriatic and Ionian Seas are bounded by both EU and non-EU countries, which determines a number of implications in terms of implementation of the environmental legal framework; nevertheless, coastal states sharing a marine region or subregion are meant to cooperate to manage marine natural resources and preserve ecosystem services, as well as adopt coordinated efforts in case of pollution accidents.

In order to support a shared and coordinated approach in case of oil spill accidents in some key areas characterized by potential hazards of contaminant dispersion, coexistence of multiple vulnerable environmental and socio-economic aspects as well as transnational relevance, a tool to assess coastal vulnerability and risk to pollution dispersion was implemented, combining multidisciplinary information, hydrodynamic and oil spill modelling, dedicated web GIS application and extensive stakeholder engagement. The assessment of coastal vulnerability and risk of contaminant dispersion are strongly dependent on data and information availability, coherence and reliability, as well as on the different national priorities and economic development levels. The heterogeneity in needs and priorities of the different countries and of the different stakeholders concerning the protection of the sea and its ecosystems requires a tailored, iterative approach that connects stakeholders with the scientific community, in order to provide data and data products that are both efficient and effective for societal needs.

Keywords

oil spills, web gis, stakeholder, risk assessment

O36.5

Interactive online calculators for farmers as a part of a toolkit for modelling agricultural impact on coastal zone

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Abstract

Nutrients leaching from agricultural areas are one of the major cause of water pollution and eutrophication of the Baltic Sea. A variety of remedial actions to reduce nitrogen and phosphorus losses from agricultural holdings and cultivated fields have been taken in the past. Therefore, it is essential to create farm production thresholds to ensure effective nutrient management. Within the WaterPUCK project, we proposed using interactive online calculators for farmers to support their decisions on fertilisation. The first calculator provides an estimation of farm nutrients (NPK) balance which is based on the “at the farm gate” method. The second calculator is used for the estimation of N leaching from the individual field. The calculators being presented are tools that allow farmers to enter data on their agricultural practices in a simple and intuitive way and that displays the results of calculations of the estimated quantities in real-time. By using a calculator, farmers can also simulate the impact that a change in their current practices will have on N leaching, and thus on soil quality and potentially higher yields in the future. Contemporary agriculture is aimed at a massive scale crop cultivation where fertilisation and plant protection techniques are extensively used to maximise production efficiency, particular attention should be paid to the risks associated with nutrient leaching. Among these threats, the potential risk of water pollution is particularly important. In this context, an interactive, easy-to-use calculator should help farmers to select well-balanced doses of fertiliser and strengthen good management practices.

This work was supported by the National Centre for Research and Development of Poland within the BIOSTRATEG III program No: BIOSTRATEG3/343927/3/NCBR/2017.

Keywords

nutrients, farm balance, leaching nitrogen, agricultural management

O36.6

Why do we need EMECS as a tool to link science to society and to facilitate adapting to environmental and societal change?*1990 – 2020: Considerations on EMECS and its achievements – the way ahead.*

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Abstract

EMECS was established in 1994 after the success of the first (1990) and second (1993) International Conferences on the Environmental Management of Enclosed Coastal Seas.

Today, the Centre constitutes a solid base for the creation of an organized network allowing governments, NGOs, universities, private entities… to exchange knowledge on an international level. EMECS's line of attack resides in its holistic approach (the "global view") to environmental issues as promoted by the late professor Olson. Based on an international and multicultural policy, EMECS promotes pluridisciplinarity based on robust scientific information. In this paper, an anthropological approach is proposed in order to understand why the aims and objectives of EMECS are so important and vital for the future of the planet. The development of science requires a reflection on our ways of life and the powers expressed in it. In the course of the 20th century, many authors realized that the means of control of the technique were broken. This is why economy should be taken into consideration. Opening to current work by contemporary economists could help the organisation to play a larger role in society.

Education should remain a cornerstone of the EMECS enterprise through (1) simplification, popularisation, explanation and universalisation, (2) getting rid of misconceptions and fallacies and (3) emancipation, freed from unpleasant or unfair social, political, or unjustified legal restrictions.

As a strategy for future work, several avenues are considered: the restoration of damaged coastal natural habitats, the need for preserving and promoting wilderness based on a healthy biological diversity. Because of the current climate change, a better understanding of natural variability is also required in order to adapt human activities to the ecology of enclosed and coastal habitats. It is further required to question concepts such as ecosystem services, the ecosystem approach or the notion of Anthropocene.

Keywords

EMECS, holistic approach, sustainability, anthropocene

O37.1

Combined effect of organo-tin alternative biocides (Sea-Nine211, Diuron, Irgarol1051) on sea urchin

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Abstract

The use of organotin compounds as antifouling agents has been banned for more than 10 years, however the alternative substances which were chosen for their low persistence have been detected in seawater and sediments around the world. Although several types of alternative substances have been detected simultaneously in seawater, few studies have investigated the combined effects of these alternative substances on marine organisms.

Therefore, in order to know the combined effects of alternative substances on marine organisms, a toxicity test was conducted using sea urchins due to their global presence and high sensitivity to toxicity. Sea-Nine 211, Irgarol 1051and Diuron were the substitutes used.

As a result, it was ascertained that the toxicity increased when Irgarol1051 and Diuron coexisted than when Sea-Nine211 alone was used.

The addition of Diuron and Irgarol1051, which usually have low toxicity to sea urchins, increased the toxicity. It is conceivable that even in seawater where various chemical substances are present, toxic effects on marine organisms may be stronger than when only a single antifouling agent is present. As an antifouling agent's character, it is hoped that it will not disperse widely in seawater, but will soon decompose after it has completed its role near the bottom of the ship.

Keywords

combined effect, biocide, ecotoxicity, sea urchin

O37.2

Modelling and assessing for marine environmental carrying capacity in semi-enclosed coastal areas: A study from Da Nang bay, Vietnam

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Abstract

Coastal waters often receive increasing amounts of waste due to local economic and population activities. However, their self-cleaning ability and environmental capacity (EC) are limited. An EC assessment provides an understanding of the load-bearing potential to adjust socio-economic activities. This research was performed for the typical bay of Da Nang, currently the most dynamically developing city in Vietnam. This research proposed an integrated information system for calculating the marine environmental carrying capacity (MECC) based on hydrodynamic and water modelling approaches combined with the GESAMP MECC model. PO_4, NH_4, TSS, and BOD were selected to evaluate MECC according to the baseline and forecast scenarios. Well-founded hydrodynamic and ecolab parameters for the given semi - enclosed coastal areas are calibrated, validated using monitoring data. The results show that the MECC to receive wastewater containing the four substances persisted in the middle of the bay but no longer functioned near the discharge sources, specifically $MECC_{PO4}$ was 4.6 – 3008.7 tons/day and 151 – 3614 tons/day in the dry and the rainy seasons, respectively; $MECC_{NH4}$ was 0.17 tons/day and 10.9 tons/day in the dry and rainy seasons, respectively; $MECC_{BOD}$ was 5.2 and 600 tons/day in the dry and rainy seasons, respectively. The MECC distribution map are conducted visually by applying GIS technology. The relevance and novelty of this study in comparison with other scientific publications will still take place in clarifying the impact of the climate change factors on the water quality and MECC calculation in the study area.

Keywords

Marine Environmental Carrying Capacity (MECC), Hydrodynamics, Semi-enclosed Coastal Area, Eco calibrated parameters

O37.3

Sensitivity of four tropical seagrass species to long-term pulsed eutrophication and implications for the nitrogen filter function as an ecosystem service

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Abstract

Eutrophication is a main driver for global seagrass loss. Together with the severe decline in diversity and abundance of seagrasses comes a loss of important ecosystem services like, for example, the filter function for land-derived substances. In NE Hainan, China, seagrass biomass decreased by 87 % between 2008 and 2017 as a result of eutrophication from aquaculture effluent input into coastal waters. At sites directly affected by aquaculture effluents with frequently high dissolved inorganic nitrogen concentrations > 8 µM, seagrass was lost almost completely. A multi-species seagrass meadow, which was remotely affected by aquaculture effluents, showed a less severe decline, but species were affected differently.

In an *in situ* nutrient enrichment experiment, we investigated the response of four seagrass species in the already chronically eutrophied environment to further nutrient enrichment. We tested the effect of nutrient availability and seasonality on morphological traits and the inorganic nitrogen (N_i) uptake of *Thalassia hemprichii, Cymodocea serrulata*, *Cymodocea rotundata* and *Halodule uninervis* in two four-week experiments using artificial NPK-fertilizer. Exposure to severe eutrophication events caused by typhoon-induced heavy rainfall resulted in a reduction of seagrass aboveground biomass. This loss acts as a positive feedback loop by reducing the overall filtering capacity of seagrass beds, which aggravates eutrophication with negative consequences for the entire coastal system. *T. hemprichii* was more resilient to eutrophication, as it could adapt morphologically. However, this species covers less of its leaf nitrogen demand though N_i-leaf uptake than the other species. This implies that the N_i filter function of a multi-species seagrass meadow decreases along with the loss of eutrophication-sensitive seagrass species under eutrophic conditions.

Keywords

Seagrass, Thalassia hemprichii, Eutrophication, Ecosystem services

O37.4

The temporal evolution of trace metals in sediment: are we on track to achieve clean and healthy seas?

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Abstract

Trace elements (TEs) frequently contaminate coastal and estuarine sediments, however, no extensive spatial and temporal scale assessment has confirmed if improvements for inputs have reduced sediment concentrations. By mining UK datasets for hundreds of Channel (UK) sites we assess sediment concentrations of As, Cd, Cr, Cu, Fe, Hg, Ni, Pb and Zn and use indices (PI, TEPI and I_{geo}) to assess the 30 year evolution of TE pollution, generating current site trajectories. For the Channel, TEPI and PI show significant reductions in the 1980s then incremental improvements followed by a distinct increase for 2010-14. Temporal I_{geo} trends show moderate pollution for Cd and Hg, but remaining stable after early reductions. This stability is also present for As, Pb and Zn, although the I_{geo} scores reflect low contamination. I_{geo} scores are low for Ni, Fe and Cr, but increasing towards the moderate pollution threshold for Ni. A moderate pollution I_{geo} score for Cu has also been increasing steadily since the mid-1990s. Some regional I_{geo} scores are increasing, however, significant increasing trends for sites are not ubiquitous. Conversely, minimal temporal change masks some significant site-specific increases and decreases. We, therefore, strongly recommend that sufficient sentinel sites are embedded within planned coastal observation networks. Our data confirm that reducing inputs *does* improve sediment pollution levels (e.g. Pb and Hg), but stable I_{geo} scores require continued global and local input vigilance. Increasing I_{geo} scores require the source identification for Ni and Fe, but this is a priority for Cu due to its elevated I_{geo} score and potent marine toxicity. Analysis indicates substantial 'hidden' inputs from ship emissions (Ni, Cu and Zn) and anti-fouling paints (Cu and Zn) with the predicted expansion of the commercial fleet and increases in the number of vessels adopting scrubber technology likely to increase these further.

Keywords

antifouling, shipping, benthic, heavy metal

O37.5

The influence of mercury contamination and vegetation type on atmospheric Hg(0) concentrations and vegetation-air fluxes in the Tagus estuary salt marshes

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Abstract

In situ air concentrations of gaseous elemental mercury (Hg^0) and vegetation-atmosphere fluxes were quantified in two saltmarshes of the Tagus estuary colonized by plant *species Halimione portulacoides* and *Sarcocornia fruticosa*. One site presented high Hg-contamination due to a nearby chlor-alkali unit (CN) and the other located in the Natural Reserve had low-to-moderate (ALC) Hg levels. Air Hg^0 concentrations were measured using a Tekran 2537A and the fluxes through a dynamic flux chamber. Concentrations of Hg^0 were higher at CN (1.08–18.15 ng/m^3) than in ALC (1.18–3.53 ng/m^3). While air Hg^0 concentrations at ALC varied diurnally and were positively correlated with meteorological parameters, the highest air Hg^0 concentrations at CN were found during the nighttime. These results suggest that photoreduction was not driving the air Hg^0 concentrations at CN. Vegetation-air Hg^0 fluxes were low in ALC and ranged from -0.76 to 1.52 ng/m^2 (leaf area)/h^1 for both plants. Higher Hg fluxes were observed for both plants in CN, ranging from -9.90 to 15.45 ng/m^2 (leaf area)/h^1. Here, the mercury fluxes were considered less reliable due to large and fast variation of ambient air Hg^0 concentrations, which may have been influenced by emissions from the nearby chlor-alkali plant and/or the known historical contamination. Additionally, the lower height of planetary boundary layer might also have influenced the ambient air Hg^0 measurements and consequently the calculation of vegetation-air Hg^0 fluxes. Nevertheless, diel variation of land and sea breezes may have an effect on the regional distribution of atmospheric Hg^0. Further investigation is required concerning the improvement of the experimental setup to verify and monitor local sources of atmospheric Hg^0 emissions, and evaluate vegetation-air Hg^0 fluxes, especially in heavily contaminated sites. Future work should investigate similar Hg “hotspots” with seasonal variations and with different saltmarsh plant species.

Keywords

Gaseous elemental mercury, Mercury volatilization, Salt marsh vegetation, Mercury contamination

O37.6

Mercury methylation and monomethylmercury demethylation rates in saltmarsh sediments from Tagus estuary and Ria deAveiro: The role of plants and seasonal effect

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Abstract

Saltmarshes are known as accumulation areas for contaminants, namely mercury (Hg), and play an important role in its methylation/demethylation processes. Sampling campaigns were performed in different seasons (spring, summer, etc) in two Portuguese aquatic systems: Tagus Estuary and Ria de Aveiro, both contaminated by anthropogenic mercury.

Non-vegetated and vegetated sediment samples were collected in the two study areas. The vegetated samples contained three specific species of plants: *Halimione portulacoides* (HP)*, Juncus maritimus* (JM) and *Sarcocornia fruticosa* (SF). The experimental design was used to evaluate the influence of plants specie and activity in the methylation of Hg and monomethylmercury (MMHg) demethylation in these environments. For the methylation studies, stable isotope tracers of $^{199}Hg^{2+}$ and $CH_3{}^{201}Hg^{+}$ were used, followed by isotope-specific detection by inductively coupled plasma mass spectrometry.

Mercury methylation and MMHg demethylation rates were then simultaneously determined in sediments non-colonized and colonized by halophyte plants. Other environmental parameters like ambient Hg and MMHg concentrations, total content of Iron and manganese, biomass content, organic matter content, etc, were also determined.

Results showed higher concentrations of ambient THg and MMHg in Ria de Aveiro. The highest concentration of THg was found in Laranjo (LAR) saltmarsh in sediments colonized by JM (58525 ng/g) and the highest concentration of MMHg was found in Chegado (CHE) saltmarsh in sediments colonized by HP in summer (334.3 ng/g). The highest methylation rate was also observed in CHE in sediments colonized by HP in summer (0.452/day^{1}) and the highest demethylation rate was found in Rosário (ROS) saltmarsh in Tagus estuary (25.6/day^{1}) in spring.

Results suggest that: halophyte plants influenced Hg methylation rates; this methylation rates are species-specific and influenced by Hg contamination, and; summer conditions enhanced MMHg formation possible due to higher microbial activity during the warmer season coupled with the higher activity of the plant.

Keywords

Mercury contamination, Saltmarsh vegetation, Estuaries, Methylation/Demethylation

O37.7

Ex vivo effects of nanoparticles on seabream spermatozoa

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Abstract

The technological advantages obtained from the use of nanoparticles (NPs) have led to their widespread discharge into the environment. Based on their estimated releases and uses, TiO_2 NP and Ag NP are the most relevant NPs in terms of exposure to humans and the environment.

Despite NPs extensive use, the knowledge about its effects on marine organisms is still limited, especially concerning the potential toxic effects on reproduction. The available information on nanoreprotoxicity, mostly in humans, demonstrated that NPs cross through biological barriers into reproductive tissues, inducing hazardous effects in sperm functionality. Hence, this study aimed to evaluate the potential reprotoxicity of realistic concentrations of TiO_2 NP and Ag NP at the moment of fertilization in seabream (*Sparus aurata*).

Sperm was released by abdominal massage and was exposed for 1 h to realistic concentrations of TiO_2 NP and Ag NP. Several parameters were determined: sperm motility using CASA system, mitochondria functionality using flow cytometry, DNA integrity using comet assay, and antioxidants profile (CAT, GPx, and SOD) by spectrophotometry.

No alteration of sperm motility parameters, mitochondrial function, and DNA damage was found for both NPs. In contrast, the antioxidant responses were dependent on the NP. After exposure to TiO_2 NP, all antioxidants were depleted, while in the presence of Ag NP only SOD decreased.

Despite there was no alteration in the motility parameters, mitochondrial function, and DNA integrity, the depletion of the antioxidants suggests sperm susceptibility towards these NPs. The depletion of the antioxidants after short-term exposure is an ecologically relevant finding, demonstrating that at the moment of fertilization, realistic concentrations of these NPs challenge the antioxidant machinery. Sperm susceptibility towards these NPs, especially for TiO_2 NP, must be further evaluated as long-term exposures may affect gametogenesis.

Keywords

Nanoparticles, Sperm, Marine fish, Ex vivo

O38.1

The fish community structure and habitat utilization in the Mhlathuze Estuary (KwaZulu-Natal).

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Abstract

The Mhlathuze Estuary, formed during development of Richards Bay Harbour in the 1970s, is an important estuary for biodiversity and habitat diversity in KZN. Limited information is available on habitat utilisation of its fish community. The current study assessed the fish community structure, in particular habitat utilisation in juvenile marine fish. Fish where sampled using beam trawls and seine nets, in five habitats (mudflats, sandbanks, mangroves, eelgrass beds and river canal), seasonally between 2016-2018. Permanova showed significant differences in community structure between different habitats. Eight-five species were recorded, with 23 accounting for 95% of the catch. The system was dominated by *Ambassis* spp. (52.0%), Mugilidae spp. (25.2%) and *Rhabdosargus* spp. (7.5%). Juveniles sized 10-50mm contributed 92% of the catch, reflecting the nursery importance of the system. Highest species count was recorded in mangrove habitat, followed by mudflats. Highest CPUE was recorded in the river canal and eelgrass beds. However, loss of the eelgrass beds halfway through the study severely affected fish diversity; given its known importance as fish habitat. The estuarine fish component showed a relative increase in abundance compared to previous studies, with *Ambassis* spp. more than doubling in number while dominant marine taxa declined, indicating the extent to which the estuarine functioning has changed over past decades. Increasing pressure from freshwater deprivation, impoundment, catchment degradation and poaching and the resultant die-off of the eelgrass beds all negatively affect estuarine functioning. This emphasises the need for higher conservation protection of the habitat diversity in this important estuary.

Keywords

fish community, habitat utilisation , nursery

O38.2

Shoreline evolution of the Niger Delta of Nigeria 1987 -2019

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Abstract

The shoreline is the interface between the land and water in the coastal zone. The shoreline changes dynamically in response to the interactions among a suite of forcing mechanisms including waves, tides, rivers, storms, tectonics and biophysical processes and human interventions. Shoreline dynamics could be in the form of erosion (landward movement) or accretion (seaward advance) of land. The migration of the shoreline has effect on coastal communities and infrastructure. Given that the coastal zone and deltas are some of the most populated and economically important landscapes globally, an improved understanding of the rate of change and direction of movement of the shoreline is critical towards ensuring a sustainable coastal zone. This study undertakes an assessment of the shoreline dynamics of the Niger delta of Nigeria. This is in the attempt to understand how interactions between natural and anthropogenic forcing processes have influenced the dynamics of the Niger basin and hence motivated morphological changes on its delta. The study employed satellite images from Landsat for time series analysis of shoreline rates of change between 1987 and 2019. Satellite images Landsat 5 TM (1987) and Landsat 8 OLI (2019) were downloaded via the USGS Earth explorer tool. The year 1987 was chosen as the base year as that was when Landsat data with acceptable cloud coverage could found for the delta. The decade 1980s has also been shown to be significant as it marked the height of human interventions within the Niger basin and in the delta demonstrated in dams and reservoir closure and increased oil exploration activities. Analysis was carried out using the Digital Shoreline Analysis System (DSAS), an ArcGIS extension designed by the US Geological Survey Agency. Highlights of the preliminary result indicate dominance of erosion with minor areas of accretion over the delta.

Keywords

shoreline dynamics, erosion/accretion, rates of change, Niger delta

O38.3

Getting in first - priority effects and the establishment of communities on coastal defences

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Abstract

The construction of coastal defences to preserve important infrastructure is becoming a primary response to the predicted sea level rise estimations. Depending on what time of year these defences are installed they may develop different communities depending on both the availability of habitable space and the larval supply. We conducted clearance experiments across three different sites over an 8 year period. Areas of natural bedrock, concrete and granite structures were cleared at different times of year and the subsequent recovery monitored over an 8 year period. Here we present the findings of the clearance experiment to explore whether or not priority effects create different stable marine communities on coastal defences.

Keywords

Priority effect, Communities, Seawalls, Sea defences

O38.4

Trapping Blue Carbon– the potential Super Power of Managed Realignments

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Abstract

There is increasing recognition of importance and potential of coastal habitats in locking away Blue Carbon and thus helping to mitigate climate change. Saltmarshes are known to be highly effective carbon sinks and can sequester carbon at higher rates than terrestrial ecosystems. This presentation will review the evidence for carbon trapping in marshes restored through managed realignment schemes. These restored marshes are evidently 'super trappers' of carbon and sediment, with the amount of carbon they initially trap tending to be much higher than in nearby mature habitats. This is due to such sites playing catch up with surrounding intertidal habitats, having been cut off from tidal inundation for decades or centuries. Sites have been shown to sequester many times as much carbon as mature habitats in the first few years post implementation, with those located in estuaries with high sediment loads (e.g. the Humber) potentially locking away much more. We have analysed accretion rates at 12 existing UK managed realignment schemes and estimated the amount of carbon trapped in their sediment to describe their value. The costs of intertidal habitat creation schemes can be very high, particularly in areas of the country where competition for land is high. Carbon markets could provide a considerable source of funding for future restoration work. There are, though, still gaps in our understanding about some carbon processes (including the role of autochthonous and allochthonous sources), and we are not yet able to calculate all the bio-geochemical processes with sufficient accuracy to meet 'verified carbon standards'. There is much work being done therefore to better understand the value of restored marshes and help build the evidence for applying carbon crediting systems, whilst also developing pragmatic ways to embed Blue Carbon valuations into real-world decision making. This study provides a contribution to this work.

Keywords

blue carbon, carbon sequestration, managed realignment, accretion

O38.5

Impacts of small coastal infrastructures on seagrass carbon stocks

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Abstract

Seagrass meadows, through their large capacity to sequester and store organic carbon in their soil, contribute to mitigate the impacts of climatic change. However, these ecosystems have experienced large losses and degradation worldwide due to anthropogenic pressures, and they continue to be among the most threatened ecosystems on Earth. At the local level, seagrass meadows are commonly impacted by coastal constructions either directly (replacement of the meadows by the structures or burial) or indirectly (changes in the hydrodynamic or light regimes due to the structures). When a meadow is impacted, the vegetation is partially or completely lost, and the sediment is exposed to the atmosphere or water column, resulting in the erosion and remineralisation of the carbon stored, which is eventually released as carbon dioxide. Here we assessed how small coastal infrastructures in a coastal lagoon affected the sedimentary organic carbon stocks of seagrass meadows. Three intertidal areas colonised by seagrasses and impacted by the construction of a bridge and two pontoons were selected in the Ria Formosa (Portugal) based on the analysis of historical satellite images. At each site, the sedimentary blue carbon stock was assessed in the impacted area and the adjacent seagrass meadows by extracting 2.5-m long cores, in which the organic carbon content was measured. We observed that the sediment in the impacted areas was mainly sand whereas that from the well-preserved meadows presented a higher percentage of silt and clay. These differences are reflected in the organic carbon stock, which was, on average, 1/3 lower in the impacted areas than in the adjacent meadows. These results showed that, although the impacted area was not large, the coastal infrastructure caused a significant reduction of the sedimentary carbon stock and the total disappearance of the meadow, and consequently a total loss of its carbon sequestration capacity.

Keywords

Blue Carbon, Impacts, Seagrass, Anthropogenic pressure

O38.6

The use of underwater video mosaics for comparative analysis of benthic megafauna in the upper sublittoral of glaciated and ice-free Arctic fjords

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Abstract

Increased melting and retreat of glaciers on Svalbard leads to the release of coastal marine habitats in the upper sublittoral for colonization by benthic macroorganisms. The study of this process is important for understanding the processes occurring in the Arctic. However, complex bottom topography and the presence of floating ice significantly complicates the use of traditional sampling methods, forcing to look for alternative approaches. One such technique is underwater visual technology, which has grown in popularity in recent decades based on its effectiveness in hard-to-reach places. In our work, we show that the use of an underwater video mosaic based on video filming along transects in the upper sublittoral can be a reliable method for identifying communities of visible macro-fauna, as well as for comparative analysis of glaciated and ice-free Arctic habitats.

Underwater video filming was carried out in July-August 2018-2019 in the upper sublittoral (2-66 m) of Hornsund and Isfjord areas (western Svalbard), representing two ice-free and two glaciated sites. The 2.8 hours of video materials were obtained using an ROV and "drop-down" video cameras. Video footage was transformed into 148 video mosaics, from which 35 biological features (morphologic taxa) were identified to the lowest possible taxonomic level, which were further ascribed to benthic functional groups (feeding type and mobility mode), and those were used for further analysis of benthic communities.

The study showed that benthic communities near retreating glaciers are largely dominated by mobile fauna and scavengers, while communities in ice-free sites are more diverse and consist of sessile and discretely mobile suspension feeders and other groups of benthos. Moreover, the morphological and functional composition of macrofauna reflected also conditions in turbid water riverine bays. The underwater imagery proved to be a rapid and sufficiently reliable method for the characterization of benthic communities in the Arctic upper sublittoral.

Keywords

Benthic communities, Underwater video, Video mosaics, Arctic fjords

O38.7

The importance of geomorphology, sea-level change and human action in the recent evolution of saltmarshes along the Tróia peninsula, Sado estuary, Portugal

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Abstract

Introduction

Saltmarshes are valuable ecosystems, crucial in shoreline protection. Understanding their recent dynamics is essential to create mitigation plans, especially against SLR.

This work studies the evolution of six saltmarshes located along the Tróia sandspit (fig.1A) using historical aerial photographs with the goal of (1) determining multi-decadal trends of saltmarsh change; (2) interpret them in the context of marsh geomorphology; and (3) relate them to concurrent changes in sea-level & land-use.

Methods

A large dataset of aerial photographs and orthophoto-maps was acquired, spanning the period 1942-2018. The photographs were georeferenced through back-stepping and geomorphological sketches were created through heads-up digitizing. Overlay analysis was performed to create maps of differences between sequential years and for the entire interval. Lastly, several landscape indices were calculated to assess marsh fragmentation throughout.

Results

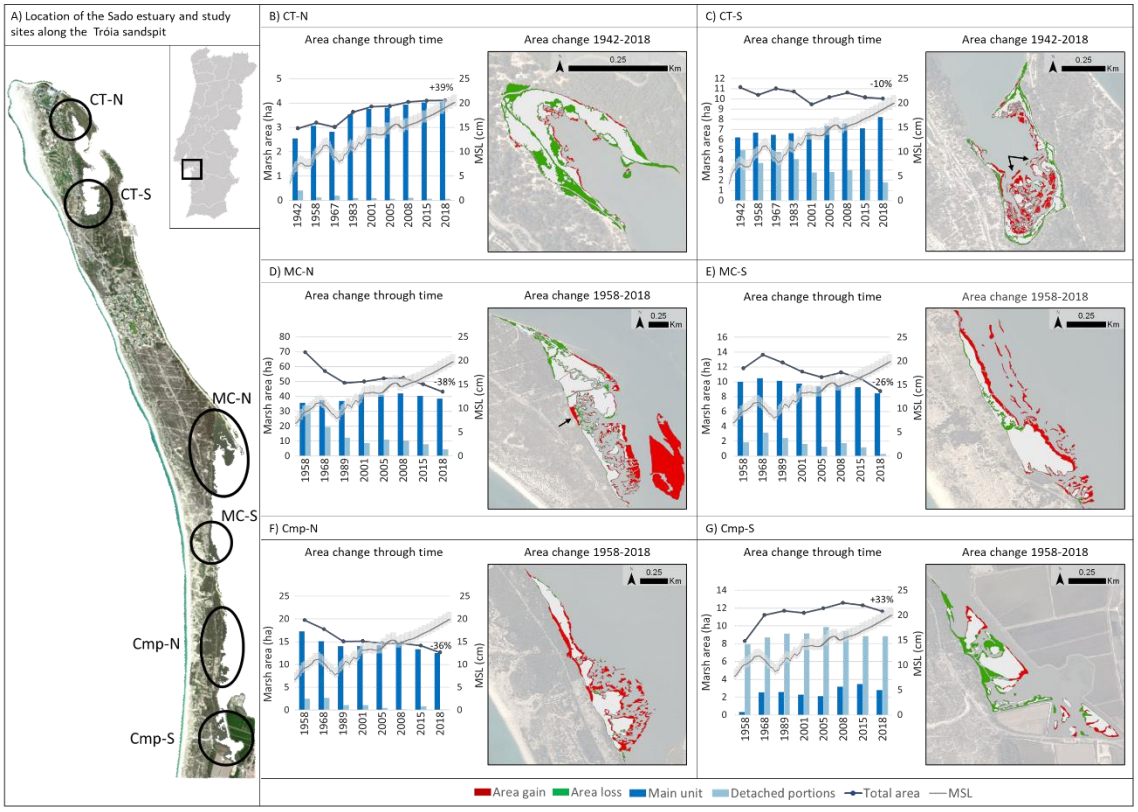
The progression of the marsh area and the overall changes during the study period are shown in figure 1.

Only CT-N (fig.1B) and Cmp-S (fig.1G) increase in size, all other marshes suffer substantial losses in total area. Where marsh islands exist, they disappear first through fragmentation and drowning. Once the main unit is exposed to wave action, marsh edge retreat begins or accelerates, primarily via erosion and slumping. Availability of accommodation space and level of protection seem to be key factors in marsh resilience.

There appears to be a link between the rise of the mean sea-level and the colonization of terrestrial areas, as well as with the drowning of the marsh islands.

Direct human action can be observed in CT-S (fig.1C) where the presence of a tide mill in the past defined the marsh's morphology; and in MC-N (fig.1D) where the marsh was destroyed to build a cement platform.

Globally, these saltmarshes shrunk over 30ha (≈27%) in the past 70 years.



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O39.1

Factors controlling the subtidal distribution of suspended Mesozooplankton carcasses in a mid-latitude estuary

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Abstract

The southern zone of Chile —from the province of Arauco to Seno de Reloncaví— has a relevant number of estuaries. Together with their wetlands, these estuaries make up an ecosystem rich in multiple plants and animal species. One of the most outstanding estuaries corresponds to the Valdivia River. This river is relevant in the economic dynamics of Valdivia city.

This research implemented an idealized 2D-vertical subtidal model to understand the transport mechanisms and spatial distribution of floating and suspended MesoZooplankton Carcasses (MZC) of sizes around 500μm in the Valdivia River Estuary (ERV). Mesozooplankton, particularly Copepods, are the most abundant metazoans in aquatic ecosystems and represent an essential link between primary producers and higher trophic levels.

The idealized model assumes stationary conditions of the characteristic regimes of the VRE to estimate the horizontal and vertical circulation along the estuary. For the calibration of the model, subtidal current profiles were used to determine the eddy viscosity coefficient A_v and the records of MZC concentrations for the three different depths obtained from the 2014 and 2015 exploratory VRE campaigns obtain the vertical eddy diffusivity coefficient K_d.

The general purpose is to explain how circulation patterns (circulation drivers, such as river discharge, wind, and longitudinal salinity gradients) affect the distribution of copepod detritus in estuaries. Thus, the forcing conditions that induce the entrainment distribution of MZC towards the estuary mouth in the southern hemisphere summer. During the autumn, the intrusion of MZC at the estuary bottom near the head of the estuary, were identified.

This study highlights the importance of estuarine circulation with the identification of potential biomass hotspots along the VRE channel.

Keywords

Valdivia River Estuary, idealized model, mesozooplankton, exchange flow

O39.2

Effects of vegetation on the long-term evolution of a straight tidal channel flanked by intertidal platforms

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Abstract

Tidal channels dissect tidal environments forming networks that feed the system with water, sediments, and nutrients. These channels drive the morphodynamic evolution of tidal landscapes. The dynamics of these environments depend on the mutual interaction between hydrodynamics and sediment transport, mediated by vegetation growth. A mathematical model is developed to study the long-term evolution of a tidal channel flanked by two intertidal platforms. The computational domain is three-dimensional and is composed of a straight channel cutting through a rectangular basin. Tidal propagation is computed within the basin by a one-dimensional hydrodynamic model which describes the interactions between the channel and lateral platforms. A simple sinusoidal oscillation is applied at the seaward basin border, while a no-flux condition is imposed on other three boundaries. The morphodynamic processes are lumped into a point model, which, under the assumption of a short and shallow tidal basin, neglects the effects of advection and bedload transport. Relative sea-level rise is accounted for and set constant on all simulations. When the bed elevation exceeds mean sea level, vegetation encroaches emergent lateral platforms affecting velocity and shear stress distribution and increasing the resistance to flow. The modelling framework is able to produce equilibrium configuration for different forcings, namely tide, sediment supply, and sea-level rise, possibly mediated by vegetation growth. The synthetic channel morphologies turn out to reproduce a large variety of channels which includes those cutting through tidal flats and those dissecting salt marshes in the Venice Lagoon. Vegetation shows to have two contending effects. First, vegetation increases flow resistance on lateral platforms and favours flux concentration and channel deepening. Second, vegetation decreases the tidal prism by enhancing deposition and thus raising lateral platforms. The predominant effect depends on the sediment availability, as well as on the positioning of the intertidal tidal platform within the tidal frame.

Keywords

Tidal channels, Biomorphodynamic model, Long-term evolution

O39.3

Investigations and modelling of flow dynamics in the microtidal delta of the Pechora River

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Abstract

The Pechora is the greatest river of the Russian European Arctic flowing into the South-Eastern part of the Barents Sea named 'the Pechora Sea'. The mouth area of the Pechora River includes vast delta with anastomosing distributary network and extensive lowlands subject to inundation by excessive river runoff as well as to flooding by tidal and surge water level oscillations. During low water season tidal waves, wind surges and reversed currents can progress along the main delta channels toward the delta top (120 km) and even further upstream.

The annual runoff of the Pechora is about 151 km^3 with the maximum in spring snow melting when the peak discharge can achieved 39,200 m^3/s. The low-flow runoff is about 2,500 m^3/s in summer and 500 m^3/s in winter. The tidal regime of the Pechora Sea semi-diurnal, the tidal range is about 1 m for spring tides and 0.5 m for neap tides.

The computer model for research of inundating regime was developed, and hydrological risk for the city of Naryan-Mar and minor settlements in the delta was assessed for floods of various genesis. The model also allows to trace a pollution dissemination amidst the delta branches. The model is developed using STREAM_2D software. The calibration and verification of the model is executed on the basis of field data secured mainly in August 2020, regime data of state gauging stations also was used. The complex use of the modern hydrological and geodetic equipment made it possible to reveal previously unknown features of the cyclical changes in hydraulic parameters of the delta branches caused by tidal fluctuations in the sea level.

The model can be used both for the retrospective analysis of floods and pollution impacts, and for scenario simulations and hydrological forecast.

Keywords

runoff distribution, delta branches, flood risk, tidal cycle

O39.4

Susceptibility of water quality indexes to tidal cycle and its effect on monitoring campaigns

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Abstract

The application of Water Quality Indexes (WQI) is an essential part of the water framework directive. One of the main factors of variability in transitional waters is the tidal effect, but knowledge of its effect on WQI is still scarce. Therefore, the objective of this study is to evaluate such effect on the existing metrics (e.g. Chlorophyll's P90) used in Portugal for biological and environmental parameters. To accomplish this approach, weekly sampling was performed at two sampling points (Alcântara and Barreiro) in the Tagus estuary, during different tidal conditions. Both stations suffer from anthropogenic pressure, Alcântara being the most affected due its location near a commercial harbor and a sewage effluent from the largest wastewater treatment plant in the area. Barreiro is also affected by both anthropogenic pressures, but this station is located further away (200 m) from both pollution sources. Chlorophyll's P90 presented higher values during spring tides, at Alcântara up to 5.87 $\mu g.L^{-1}$ at low spring tides, while in Barreiro up to 6.78 $\mu g.L^{-1}$ during high spring tides. For nutrients, P90 is also used, yielding high variability for different tidal conditions. In Alcântara all nutrients had a similar pattern, with highest value at low neap tide and lowest at high spring tide. Barreiro presented lower nutrients P90 than Alcântara. At Barreiro nutrients presented different results from one another, with both low spring tides and low neap tide presenting the highest value for different nutrients. Dissolved oxygen pattern was similar in both sampling points, being P90 higher during neap tide. These results suggest that sampling during neap low tides could better expose anthropogenic pressure, since it is when residence times are higher, and the water column is lower. This can support the definition of better adjusted monitoring plans.

Keywords

Estuaries, Tidal Cycle, Water Quality Indexes, Eutrophication assessments

O39.5

Seagrasses enhance their health under mild nutrient additions

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Abstract

Seagrasses are keystone species in estuarine and coastal systems. Therefore, the health of their stands has been considered and tried as one of the most important ecological indicators. However, their ecology has not been understood well enough for the development and application of robust indices providing clear perspectives over the studied cases. Most often, Principal Components Analysis has been applied to mono-specific, geographically narrowly-confined studies, yielding results that are unclear and/or cannot be extrapolated to other species or geographical locations. Stand above-ground biomass and shoot density have been consistently on the core of these indices, moved by the renowned Self-thinning law, in the past accolade the only rule in plant ecology worthy of the name 'law'. Yet, their modular construction gifted seagrass with an intricate biomass-density relation that became indecipherable until recently. In our recent works, we found that each of plants, algae and seagrass have their own Interspecific Boundary Line (IBL): an upper boundary to their biomass-density plot setting a maximum efficiency of space occupation for each of these taxa. We also observed that healthier stands placed closer to these IBL. This distance to the IBL was successfully tested as an ecological indicator, unveiling seagrass' responses to light, temperature, depth, season and nutrient concentrations. In our first tests, we applied this metric to two species in a few locations worldwide, having found that seagrasses occupied space more efficiently (i.e., stands were healthier) subject to intermediate nutrient concentrations. These occurred not in pristine conditions but rather in locations at intermediate distances from anthropogenic sources. We now extended our analysis to more species and a larger worldwide coverage. Our results show that seagrasses systematically optimize their health under mild anthropogenic nutrient additions. Hence, a good dispersion of nutrient loadings may be the key to optimize the co-existence of Man and seagrass.

Keywords

Seagrass, Biomass-density relation, ecological indicator, space occupation efficiency

O39.6

The shifting face of long term monitoring of UK seas, the old, the new and the novel ways we measure, model and assess the state of our oceans.

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Abstract

Monitoring of UK seas is carried out under the Eutrophication monitoring program at the Centre of Environment, Fisheries and Aquaculture Science (Cefas). We collect water quality data every year that helps us assess if UK marine waters are clean and safe and work with our partner agencies to connect land and ocean based monitoring to understand the impact of land-based nutrients and pollution. Our vessels use a range of technology from SmartBuoys, moored autonomous systems capable of recording fixed point data for months, Ferryboxes installed on the vessel to automatically record data as the ship is underway, satellite information and the more traditional in-situ sampling equipment such as Niskin bottles deployed over the side of the ship to sample water from both the surface and at depth. The combination of new and novel ways of collecting water quality and plankton information presents exciting challenges of integrating high resolution and spatially rich datasets into the assessment of the state of our seas. Additionally, the ever improving technology and high resolution modelling ensures high quality information but with levels of complexity that are difficult to fit into our assessment criteria. This talk will describe what the advantages of integrating both the old and the new and the ever shifting challenges of embedding new technology into our monitoring and assessment requirements.

Keywords

Water Quality, Monitoring, Technology, Assessment

O39.7

Limiting lifeforms – grappling with GES at a local level

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Abstract

Assessment tools developed under the Water framework Directive from 2007 onwards have enabled us to classify estuaries and coasts based on phytoplankton biomass (chlorophyll-a), taxa cell counts and seasonal succession of functional groups.

However recent developments under the Marine Strategy Framework Directive and UK Marine Strategy by the UK Pelagic group has allowed us to look at our data in a different way. One of the key shifts has been the inclusion of the lifeforms concept and state space of pairs of ecologically relevant lifeforms. This allows some integration across organisations, methods and sea areas. Measurement of the shape of change in plankton communities provides new information on the state of our near- and offshore phytoplankton communities.

As part of work for the S3-Eurohab project we have applied the lifeforms concept to the inshore and offshore regions of the Western Channel with particular emphasis on potential impacts of eutrophication of the phytoplankton community.

The results suggest that the phytoplankton community may be changing in ways that correlate to changes in nutrients and particularly nutrient ratios in inshore waters and possibly climate change further offshore. These impacts may ripple further up the food chain. These views provide a compelling case to review our current thinking in both coastal and marine waters.

Keywords

Lifeforms, Plankton, Eutrophication, Climate change

O40.1

Approaches to probabilistic coastal risk assessment under future sea level projections

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Abstract

Under climate change induced sea level rise there is an increased threat to coastal communities. For coastal managers and planners the ability to predict the future hazards is, therefore, vitally important. Coastal risk assessment frameworks that use a full system approach, linking source-hazard-receptor, allow the impact of a range of potential future conditions to be assessed. Complex modelling approaches are, however, not resource efficient and a trade-off is needed between modelling the full range of conditions in the complex coastal environment and the model detail.

In the coastal management and planning community, typically a narrow selection of future sea level rise scenarios are selected for further interrogation, limiting the follow through of the complex science used to make these projections. In addition, the uncertainties implicit in future climate scenarios are rarely taken through the hazard to impact framework, resulting in poorly defined future predictions. As a result there can be a lack of trust in outputs and low levels of uptake.

In this research we establish a high level framework that, at its core, allows the uncertainties in future sea level rise projections to be fed through from flood hazard assessment to flooding impact, including the potential for risk reduction intervention. In addition, we explore the trade-offs between model complexity and the ability to model the full range of potential scenarios, given computational constraints.

Keywords

Sea level rise, Coastal risk assessment, Flooding

O40.2

A country-level estuarine pressure assessment and activity disaggregation to better inform resource management and protection

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Abstract

Effective management requires an understanding of the extent of anthropogenic pressures on estuaries. We present a systematic approach to identify, characterise, quantify and rate global change pressures at a country-level scale, using South Africa as a case-study. Six pressure categories were identified based on estuarine resources use globally: freshwater flow modification; pollution; exploitation of fish and invertebrates; habitat destruction; inlet manipulation; and biological invasions. The degrees to which pressures influenced estuaries were rated and aggregated to reflect the impact on biogeography and estuary types. Key activities within each pressure category were also identified, quantified / qualified, including the expected trajectory of change and a confidence rating. Finally, management responses were recommended to mitigate the impacts of activities associated with high pressures.

Results showed that a third of freshwater flow no longer reaches the coast (from 36 900 to 24 800 $x10^6 m^3/a$), with 15% of estuarine area under severe pressure. Near 40% of estuarine area are subject to severe land-use and development pressure; with agriculture responsible for 10% change, and urban expansion about 4%. Further, small-scale, mostly illicit, mining of sand, diamonds and heavy minerals is causing permanent habitat destruction in 12% of estuaries. There has been a significant increase in pollution pressure (e.g. 840 $x10^6 L.d^{-1}$ wastewater discharge into estuaries), with 34% of extent under severe pressure. About 15% of estuarine inlets are artificially manipulated, but these estuaries represent more than 60% of total area. Over 3 730t of fish is caught annually of which 2 600t (60%) is by illegal gillnetting, with 78% of extent severely impacted. Alien terrestrial vegetation has infested about a third of the country's estuaries, with 6% of systems being highly invaded. Aquatic invasive plant species occur in 8% of systems, whilst alien or extralimital fish occur in 25% of South Africa's estuaries.

Keywords

Pressure level assesment, South Africa, Country-level, Management Responses

O40.3

Multi-scenario analysis in the Apulia shoreline: a bayesian network approach to support coastal erosion risk assessment and management

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Abstract

Climate change is causing severe threats to natural and human systems worldwide, with relevant impacts on coastal areas where land-sea interaction occurs. According to the IPCC scenarios, they will be increasingly exposed to erosion as direct consequence of rising sea level and changing patterns of extreme events. Located at the land-sea interface, coastal areas are dynamic environments where natural and anthropogenic pressures interact at diverse spatio-temporal scales modifying their geomorphological, physical and biological features. Against this interplay, coastal managers are increasingly calling for new approaches supporting a multi-scenario evaluation of multiple risks arising from natural and anthropic stressors.

Moving beyond traditional approaches for coastal erosion risk and vulnerability appraisal, a GIS-based Bayesian Network (BN) approach was developed, exploiting functionalities of both methods to evaluate the probability and uncertainty of coastal erosion risks, and connected water quality variation, against multiple '*what-if*' scenarios, including different management measures (i.e. nature-based solution) and climate conditions (e.g. higher coastal waves). According to the spatial resolution of the available data for the case study of the municipality of Ugento (Apulia Region-Italy), the proposed BN-model was trained and validated by considering oceanographic and water quality parameters over the 2009-2018 timeframe, allowing to capture local-scale shoreline erosion dynamics and related driving forces.

The resulting output from the BN-based scenario analysis showed, even if in a minor extent, a nexus between oceanographic drivers, shoreline evolution and water quality parameters (i.e. suspended matter and diffuse attenuation), with increasing probability of high erosion/accretion along the coast and higher turbidity under potential rising maximum significant wave height. Despite constraints posed by the spatial resolution of the available data for the investigated case, the outcomes of the performed assessment represent valuable information to support adaptive policy pathways in the context of Integrated Coastal Zone Management and Disaster Risk Reduction in the Ugento shoreline.

Keywords

Coastal erosion, Water quality variation, Bayesian Network, GIS

O40.4

The evolution of Venice coast in the period 2015-2019: an advanced satellite images processing and machine learning approach to evaluate coastal erosion risk in a gentle-sloping sandy littoral

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Abstract

With increasing storminess and continuing sea-level rise, coastal erosion is becoming a primary issue along a significant percentage of littorals in the world. To assess coastal erosion risk against reference and future scenarios, it is important to study the shoreline position over years. This objective, however, becomes challenging when considering gentle-sloping sandy coasts which are commonly subjected to slow, but continuous changes.

Here we present a multidisciplinary research combining satellite image with machine learning and GIS spatial analysis tools to analyze coastal erosion risk in the Venice shoreline over the period 2015-2019. Firstly, an advanced image preprocessing (e.g. co-registration, colors normalization), that is not frequently adopted in coastal erosion studies, was performed on satellite images downloaded within the same tidal range. Secondly, different supervised and unsupervised machine learning classification methods were tested to accurately define shoreline position by recognizing land-sea areas in each image. Finally, the application of Digital Shoreline Analysis System (DSAS) tool in ArcGis was performed to evaluate the net shoreline movement overtime. The assessment was accompanied by correlation analysis with Copernicus Marine Service observations data to recognize key oceanographic drivers of coastal erosion (e.g. wave height/direction) and potential cascading effects on water quality parameters (e.g. suspended matter).

Results showed general shoreline stability in the considered timeframe. However, the high presence of anthropogenic structures (e.g. jetties, breakwaters) induces the formation of well-delimited hotspots of erosion/accretion. The correlation analysis instead showed a nexus between oceanographic drivers, shoreline evolution and water quality variations (i.e. changes in suspended matter). Despite limits posed by spatial and temporal resolutions of the data, the results obtained offer a basis to assess coastal erosion risk in coastal areas and to select the best suitable erosion defense, ensuring sustainable management of coastal communities, assets, and ecosystems, in the context of Integrated Coastal Zone Management.

Keywords

Coastal risk, Shoreline erosion, Satellite images, Integrated coastal zone management

O40.5

Co-development of a sustainable and resilient future with local stakeholders in the coastal area of South-West Messinia (Greece)

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Abstract

A strong participatory multi-actor, bottom-up approach based on collaboration across sectors is vital for triggering sustainable change and building resilient coastal territories. Local and scientific knowledge are combined through a holistic approach where key areas are identified as a dynamic system where social and environmental realities interact. This coastal social-ecological system is used as a focal point in the discussions between scientists and local stakeholders, driving the identification of the main challenges and supporting the co-design of practical and robust business road maps and policy recommendations. This approach is used to guide the future sustainable development of the coastal area, by increasing cross-sectoral synergies, connecting practices, pressures and outcomes. The definition of a sustainable future begins with a visionary exercise in which a common positive future is identified by local stakeholders, as a basis of inspiration towards sustainable transformations followed by a backcasting process to enable the formulation of future-oriented actions that go beyond “business as usual” solutions and are not constrained by vested interests and stakes. This bottom-up, system innovation approach allows genuine solutions to emerge from creative, inspirational and positive future perspectives, rather than from reactive, defensive and problem-oriented approaches while the formulation of common ambitious goals by local stakeholders across sectors allows the co-creation of a common sustainable and resilient future based on local context. The present approach has been applied to the coastal area of SW Messinia,, characterized by an increase coastal tourism development competing with traditional olive agricultural sector for land and water resource while impacting a coastal lagoon classified as a natural protected areas. It allowed the introduction of a cross-sectoral dialogue, the co-construction of a common sustainable and desirable future and the co-identification of key solutions, capitalising on synergetic activities and collaborations, capable of leading the coastal area toward a sustainable, resilient future.

Keywords

coastal management, cross-sectoral, system-innovation, stakeholders engagement

O40.6

Intertidal habitat monitoring using Earth Observation data and Machine Learning techniques - TEMITH Project

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Abstract

Mudflats, seagrasses, and saltmarshes are ecologically and economically valuable intertidal habitats, however, globally they are in decline due to numerous stressors, such as overexploitation, physical modification, and pollution. Achieving total ecosystem management (TEM) to support conservation and sustainable exploitation of the intertidal ecosystem requires extensive habitat monitoring and assessment of pressures, however, budgets for conservation and management are often limited and relevant data may not be collected or may be difficult to access or visualise in a holistic way. The Total Ecosystem Management of the InterTidal Habitat (TEMITH) project, a collaboration between Deimos Space UK and the University of Portsmouth, explored the feasibility of using Earth Observation data and artificial intelligence to facilitate the assessment of key pressures in the intertidal zone. The heavily protected, yet heavily exploited, Solent region on the south coast of England was used as a case study. Convolutional neural network (CNN) models were trained to achieve detections of three key sediment disturbance activities (bait digging, shellfish dredging, and boating) from drone and aerial imagery and from high resolution satellite imagery. Models were developed for the detection of algal mats, which can indicate nutrient enrichment, as well as seagrass and saltmarsh (intertidal vegetation of conservation importance) from high resolution satellite imagery (CNNs) and from Sentinel-2 imagery (Random Forest model). Feedback from prospective end users in an external Evaluation Workshop highlighted the relevance of the TEMITH outputs and the potential to achieve a more holistic overview (spatial/temporal) of the detected features with further development of the TEMITH services. TEMITH concluded in 2020, however further development of the algorithms is being taken forward under new pathways in 2021.

Keywords

Earth Observation, Machine Learning, Intertidal Habitats

O40.7

A review of cumulative impact assessment approaches and their applications for integrated management of marine and coastal ecosystems

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Abstract

Cumulative impacts increasingly threaten marine and coastal ecosystems. The growing interplay between climate change hazards and human-induced pressures from land-based and maritime activities are exacerbating environmental risks, resulting in severe water quality degradation, biodiversity loss and decline in the provisioning of ecosystem services for human well-being. To address these issues, the research community has started designing and testing different methodological approaches and tools that apply cumulative impact appraisal schemes for a sound evaluation of the complex interactions and dynamics among multiple pressures affecting marine and coastal ecosystems.

Through an iterative scientometric and systematic review, this study provides a state of the art of these methods, giving a specific emphasis to the identification of cutting-edge approaches (e.g., machine learning-based models) exploring and modeling inter-relations among climatic and anthropogenic pressures, vulnerability and resilience of marine coastal ecosystems to these pressures, and the resulting changes in the ecosystem services flow. Despite the recent advancements in computer sciences and the rising availability of big data for environmental monitoring and management, this review revealed a limited implementation of advanced complex system methods. Moreover, only recently experts have started integrating ecosystem services flow into cumulative impact appraisal frameworks, as generally assessments endpoint within the overall evaluation process (changes in the bundle of ES against cumulative impacts).

The present two-tiered review also highlighted a lack of integrated approaches and complex tools able to frame, explain, and model spatio-temporal dynamics of marine coastal ecosystems' response to multiple pressures, as required under relevant EU acquis (e.g., Water Framework and Marine Strategy Framework Directives). Progress in understanding cumulative impacts, exploiting the functionalities of more sophisticated machine learning-based approaches (e.g., big data integration), will support decision-makers in the achievement of environmental and sustainability targets.

Keywords

Cumulative impacts, Marine Coastal ecosystems, Multi-risk, Ecosystem services

O41.1

The influence of estuarine geomorphology and tidal wetlands on hydrodynamic changes associated with sea-level rise: examples from estuaries of SE Australia.

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Abstract

Examining the effects of sea-level rise (SLR) on estuarine hydrodynamics and ecosystem services provided by estuarine wetlands is of importance for coastal management and general process understanding of estuarine-wetland systems. Estuarine hydrodynamics and tidal wetland morphology are interrelated, however, current approaches of assessing SLR effects typically consider estuarine hydrodynamics and estuarine wetlands independently.

This study explores the inter-relationships between SLR, estuarine hydrodynamics and tidal wetlands by using empirical observations of tidal dynamics and wetland inundation regime, and hydrodynamic modelling of SLR. The analysis focussed on the "wave –dominated" coastline of SE Australia which includes wetlands within estuaries at a range of infilling stages. Results of hydrodynamic modelling of SLR for several microtidal estuaries suggests that changes in estuarine hydrodynamics are mainly controlled by the geomorphology and degree of estuarine infill. For example, the modelling indicated a doubling of tidal range in an immature estuary, while tidal range remained stable in mature estuaries with extensive wetlands. Furthermore, analysis of tidal observations showed that estuarine hydrodynamics are influenced by the presence of mangroves and salt marsh along estuarine banks, indicating changing wetland morphology should be taken into account when modelling SLR in estuaries. This study confirms that integrating approaches are required to study the effects of SLR on estuarine hydrodynamics and tidal wetlands, which should be considered simultaneously to accurately incorporate the links between estuarine geomorphology, sedimentary infilling and tidal wetlands.

Improved understanding of the estuarine-wetland system will support managing estuaries and tidal wetlands more effectively because important inter-relationships can be considered in coastal management and SLR planning. In addition, comparison of SLR modelling in different estuaries presented in this study may enable first-pass estimates of how hydrodynamics change in certain estuarine-wetland settings.

Keywords

estuary, sea-level rise, geomorphology, tidal wetlands

O41.2

Sensitivity of compound flooding events in estuaries to climate hazards

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Abstract

Coastal flooding hazards occur when extreme sea and/or river levels exceed a local threshold, e.g. a sea defence. High fluvial flows due to precipitation can co-occur with storm surges which are often both generated by low-atmospheric pressure systems to amplify flood hazard. A clear understanding of the magnitude, coincidence, and relative timing of extreme sea and river levels under current and future climates is crucial for flood hazard assessments. High-resolution (15-minute) river flow data is combined with tide gauge data spanning 30 years to establish the likelihood of single and compound flooding hazards in over 150 UK estuaries. The analysis quantifies co-dependence between the driver of compound flooding and establishes the likelihood of flooding events in each estuary. The analysis identifies clear spatial variability in correlations between peak river and surge magnitudes; an east-west split across the UK indicates that catchment on the west coast are more likely to experience compound hazards. Peak flows exceed the 95th percentile for less than 24 hours, indicating sub-daily analysis of river sea-level co-occurrence is needed to resolve the hydrographs. The influence of local site characteristics, including catchment area and transmission time, on the co-occurrence of storm surge and river flow is explored to determine controls on these trends. The analysis is combined with new UKCP18 climate projections for precipitation and temperature, and storm surge and sea-level rise projections to establish the likelihood of single and compound flooding hazards in the future. This analysis is the first-time climate and ocean projections have been applied to estuarine environments to assess changes in the magnitude and spatial and temporal distribution of these joint-probability drivers, and provides new understanding of fluvial and sea-level interactions.

Keywords

Compound flooding, River-surge dependence, Climate hazard, Modelling

O41.3

Estimating net community production in a macrotidal estuary using high-frequency dissolved oxygen measurements

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Abstract

Coastal zones play a major role in Earth's biogeochemical processes by acting as a natural convergence zone for air, sea and land components. In estuarine environments, the concentration of dissolved oxygen (DO) is a key indicator of water quality due to its direct relation with biological and environmental processes. An accurate estimate of the O_2 flux at the air-sea interface can be achieved through the open water diel oxygen method, an integrative technique to calculate primary production from in situ oxygen mass balance through continuous measurements of DO. A year-long high-frequency (15 minute) environmental data time series obtained from a Southampton Water mid-estuary moored data buoy, provided near surface measurements of temperature, salinity, chlorophyll, DO, pH and turbidity throughout 2019. Changes in dissolved oxygen were used to estimate daily integrated gross primary production (GPP), ecosystem respiration (ER) and net community production (NCP), also known as net ecosystem metabolism. An annual mean NCP for Southampton Water of -0.91 mmol O_2 m^{-2} d^{-1} showed a more or less overall balance between GPP and ER, leaning slightly towards a heterotrophic state driven by inputs of external organic matter with O_2 being absorbed and CO_2 released to the atmosphere. However, seasonal productivity events shifted this state for a few days in spring and late summer to net autotrophic conditions, with a longer sustained high productivity period in mid-summer during a high biomass *Mesodinium rubrum* bloom. This change meant that for short periods, the mid estuary ecosystem was a strong CO_2 sink and a source of organic matter and dissolved O_2. The results of this study represent a valuable input to the understanding of key factors influencing seasonal patterns in net community production in estuarine ecosystems and a contribution to air-sea O_2 and CO_2 flux description in coastal zones.

Keywords

Net community production, Dissolved oxygen, Phytoplankton blooms, High-frequency data

O41.4

Assessing future development of estuarine salt marshes

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Abstract

In the last decade, an increasing body of literature is dedicated to include vegetation dynamics in morphological models, often called biogeomorphology or ecomorphology. Namely, feedback between plants and morphology have shown to substantially affect the shaping of landscapes. Within ecomorphological salt marsh models, the spatial scale is often limited to a stretch of marsh (~1km wide). However, there are no modelling studies focussing on the ecomorphology of estuaries salt marshes on the long-term (including climate change (CC)) and on the actual estuarine spatial scale, hindering the use of such models for projections of future development of estuarine salt marsh systems in order to evaluate future salt intrusion. The aim of this study is to bridge this gap.

An idealised ecomorphological salt marsh model is developed to study spatial development and expansion of salt marsh vegetation on an estuarine scale. A harmonic tide, constant wave heights and river discharge is included (Figure) and a rising sea-level (SLR) is implemented to represent CC. The model uses a dynamic vegetation density modelling approach, which is often applied within literature. Vegetation represents the salt marsh species *Spartina anglica*. For validation purposes, simulations are performed without SLR as well. These results are compared to available literature on marsh development. In addition, results wherein SLR is included will be compared with idealised model studies on marsh development under SLR on smaller spatial scales. Furthermore, simulations will be performed using varying initial marsh areal, vegetation characteristics and rates of SLR.

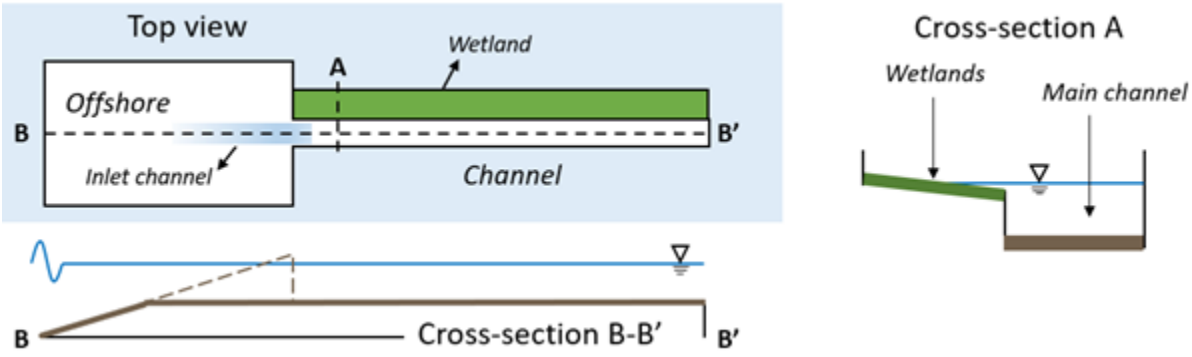

Figure: Schematised domain of the idealised estuarine salt marsh model

Currently, we are working on the wetland development under the impacts of CC. Hereby, the ecomorphological development of the initially vegetated stretch as well as lateral expansion of the marsh is assessed, under influence of a rising sea-level.

Keywords

Salt marsh, Sea-level rise, estuary, models

O41.5

Biomarker responses to salinity and temperature gradients in a marine fish

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Abstract

Phase transitions in marine fish life history frequently occur simultaneously with changes in habitat use. This is particularly important for fish species with complex life cycles, whose early life involves migrating from spawning grounds to estuarine nurseries. Migration into estuaries requires fish to adapt to a highly dynamic environment characterized by daily fluctuations in water temperature and salinity, which poses additional physiological challenges to juvenile fish.

We performed a controlled laboratory experiment (98 days) to evaluate the biomarker responses of juvenile Senegalese sole (*Solea senegalensis*) to several temperature (16, 21ºC) and salinity (5, 18, and 30) combined treatments, which mimic the environmental conditions experienced by sole juveniles during estuarine residency. After the end of the experiment, we retrieved brain, gills and liver from each fish and determined a wide range of biomarkers indicative of oxidative stress (CAT, GPx, SOD, GR, GSHt, LPO), neurotoxicity (AChE) and metabolic functions (LDH, IDH).

The observed responses were organ-dependent. Oxidative damage given by LPO was only observed in gills and brain, but only at the lowest temperature tested (16ºC). For gills, LPO levels were higher at the extreme salinities (5 and 30), while for brain LPO was higher at brackish salinity (18) when compared with near freshwater conditions (5). The influence of salinity and temperature do not influence AChE activity in brain, demonstrating the inexistence of neurotoxicity.

LDH activity remained constant in all treatments, showing a consistency in liver anaerobic metabolism. In contrast, IDH was temperature-dependent: higher activity at salinity 5 at the warmest temperature (21ºC) indicates a higher rate of NADPH recycling, pointing that under hypoosomotic stress there is a higher energetic demand for the defense mechanisms against oxidative stress or fatty acid metabolism.

Our results provide further insights on the influence of temperature and salinity on the physiological processes of fishes in estuaries.

Keywords

Stress biomarkers, Nursery areas, Salinity, Metabolic function

O41.6

Modelling the morphodynamic development of intertidal shoals and sea-level rise adaptation

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Abstract

Introduction

Intertidal shoals are key features of estuarine environments worldwide. Climate change poses questions regarding the sustainability of intertidal areas under sea-level rise (SLR). In contrast to mudflats, sandy shoals have drawn limited attention in recent research. Inspired by channel-shoal systems such as the Wadden Sea (The Netherlands), our research investigates the mechanisms that drive the long-term morphodynamic development of sandy shoals and its SLR adaptation.

Methods

We apply a high-resolution (35×65 m) process-based model (Delft3D) to simulate the evolution of a sandy channel-shoal system in a schematized (20×2.5 km) tidal basin. An initial, mildly sloping bathymetry is subjected to constant semi-diurnal (M_2) tidal forcing, sediment supply, and small wind-generated waves (10-20 cm) modeled by SWAN.

Results

A positive morphodynamic feedback between hydrodynamics, sediment transport, and morphology causes the emergence of large-scale channel-shoal patterns (Figure 1). Over centuries, a steady morphological state develops by a balance between tides, sediment supply, and wave action.

SLR leads to increased flood dominance which triggers sediment import into the system. Shoals accrete in response to SLR. Seaward shoals near the open boundary sediment source have higher accretion rates compared to landward shoals. Similarly, on a shoal-scale, the highest accretion rates occur at the shoal edges near the channel sediment source. Waves help redistribute sediment supplied from the channels over the shoals by inducing resuspension. Mud fractions lead to faster, more uniform, accretion and muddier shoals under SLR.

Discussion

The morphodynamic adaptation lags behind SLR which eventually leads to intertidal area loss and increased shoal inundation. Implementing a large-scale, high-resolution approach, allowed for highlighting spatial variations in the morphological response. Short-term shoal dynamics by wind waves are of high relevance for the long-term morphological adaptation to SLR.

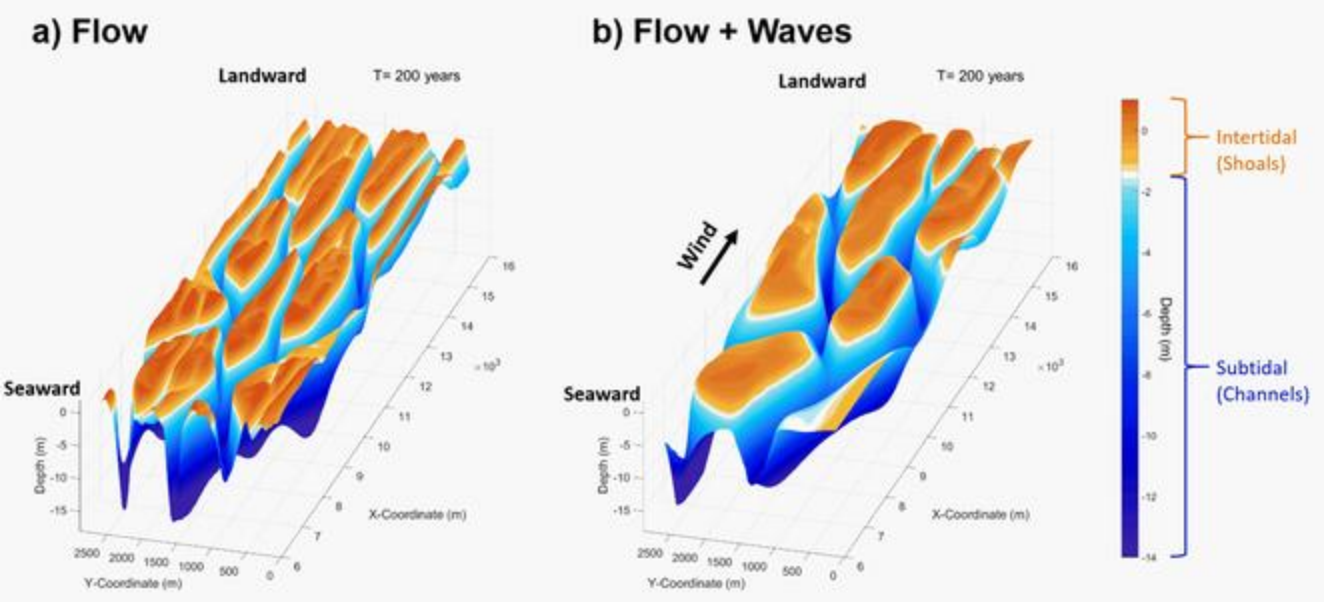

Figure 1. Modelled channel-shoal system under forcing conditions (a) without, and (b) with wave action.

Keywords

Intertidal, Morphology, Modelling, Sea-level rise

O41.7

Sea level rise versus dredging strategies; which one has more impact on estuarine morphodynamics?

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Abstract

Channel-shoal patterns evolve in estuaries due to the interaction between tidal forcing, waves associated sediment transport and morphodynamic developments. While shoals comprise unique ecosystem values, the main channels are often used as access channels to ports connecting ocean transport to inland shipping and other transport mechanisms to the hinterland. The access channels often need to be sustained by regular dredging and disposal activities. Anticipated sea level rise scenarios will impact the morphodynamic evolution of estuaries. It is questioned whether the estuarine morphology can keep up with sea level rise. Tidal asymmetry and tide residual sediment transport may change due to possible deepening of channels and drowning of intertidal flats.

This study aims to investigate the relative importance of sea level rise and different dredging strategies on the morphodynamic behavior of the Western Scheldt Estuary in the Netherlands. We apply a process-based model (Delft3D) to assess potential intervention measures. Our methodology describes 100 year morphodynamic runs that we subject to different sea level rise scenarios (rates and linear vs exponential) and dredging strategies that maintain a prescribed bed level with respect to a rising mean sea level under different disposal strategies.

Model results show that the estuary slowly deepens since morphodynamic adaptation lags behind sea level rise. SLR increases the sediment export from the estuary. More landward sections maintain their import trend albeit at a decreased rate. Despite the clear signal by sea level rise, applied dredging strategies seem to have the major impact on sediment redistribution within the estuary. Disposing dredged sediments in deeper parts of the channel leads to less sediment export from the system than disposing the sediments on shoals. However, the former disposal strategy leads to a more pronounced drop in intertidal area.

Keywords

Estuarine morphodynamics, Sea level rise, Dredging strategies, Intertidal area

O41.8

Reno matt-tropolis: how an artificial structure can provide habitat for species

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Abstract

Estuaries are extremely important systems offering nursery and foraging grounds for many species. With the increasing threat from climate change and sea-level rise, the armouring of coastlines has become common practice, particularly to withstand coastal erosion. The transformation of soft sediment habitats to hard, artificial habitats can lead to changes in species diversity, composition, and distribution. As there is limited information regarding the ecological impacts of using Reno mattresses (wire mattresses filled with rocks) to combat erosion, this study investigated the ecological differences of these structures compared to natural seagrass (*Zostera capensis*) habitat in the Keurbooms estuary, South Africa. Seasonal benthic invertebrate and fish abundances and assemblages were assessed from winter 2018 to spring 2019. Macroinvertebrates were assessed using standard core sampling and the non-destructive method of mini Baited Remote Underwater Video Systems (BRUVs) was used to sample fish. Significantly greater abundances and richness of fish were found to utilize artificial structures compared to natural habitat. Invertebrate taxa displayed some overlap between habitats, however, three higher taxonomic groups were only recorded within Reno mattress habitat with only one taxon unique to the eelgrass habitat. This study provides new information on the ecological efficacy of Reno mattress structures used in coastal management which can inform future coastal erosion control practices.

Keywords

Ecological engineering, Artificial structures, ocean sprawl, mini BRUVs

O42.1

Exploring the impacts of altered nutrient ratios on coastal phytoplankton communities

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Abstract

Nutrient pollution of coastal waters is a global problem; resulting in increased phytoplankton biomass, degraded water quality, and decreased oxygen concentrations. The management of phosphorus, primarily through sewage treatment and regulation on phosphorous in cleaning products, has been much more successful than attempts to reduce the amount of nitrogen entering coastal waters, particularly from diffuse agricultural sources. This has led to an imbalance of nutrients, with high nitrogen to phosphorous ratios. This change in nutrient balance has implications for coastal phytoplankton communities. Phytoplankton provide 50% of the world's oxygen, so ensuring that communities remain in a healthy state is incredibly important for all of us. My project aims to understand how these imbalances impact UK phytoplankton community composition and the potential for using these changes as an indication of environmental/ecological status. Preliminary analysis of long-term changes in coastal waters and impacts on phytoplankton for Liverpool bay will be presented. The combination of estuarine, coastal, and offshore long-term data provides a unique dataset to explore how nutrient imbalances are impacting the phytoplankton community.

Keywords

Eutrophication, Phytoplankton, Nutrients

O42.2

Model derived threshold values for the OSPAR assessment of eutrophication in European marine waters

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Abstract

Here we present the results of the 2020 online workshop of the OSPAR Intersessional Correspondence Group on Eutrophication Modelling (ICG-EMO). The aim of the workshop was to simulate pre-eutrophic conditions on the western European Shelf, with the specific aim of using the ensemble results to set thresholds for eutrophication indicators for the next OSPAR Common Procedure (COMP4, 2022). To this end, 8 modelling centres from around Europe participated with their most relevant marine ecosystem model. Inputs and boundary conditions were prescribed in order to generate comparable model simulations. Riverine loads, Baltic inflow and atmospheric deposition were applied at estimated pre-eutrophic levels for nitrogen and phosphorous compounds, while other inputs were kept at current levels. The period 2006-2014 was simulated for the current state and two historic input scenarios by most participants, and mean values for 2009-2014 were reported for the new assessment areas used by OSPAR for a range of ecosystem variables.

COMP4 threshold levels were calculated for standard indicators and compared to the previous thresholds based on sparse observations. In general lower thresholds were found compared to the previous observation-based thresholds, particularly offshore. The modelled results also allow for a quantification of the new COMP4 target area variability in time and space, showing higher variability in the German Bight target areas. Furthermore we consider changes in additional characteristics like pelagic and benthic biomass and biomass ratios (e.g. phytoplankton:zooplankton, phytoplankton:bacteria) with respect to the simulated pre-eutrophic conditions and the current state.

Keywords

Eutrophication, Modelling, Thresholds, Ensembles

O42.3

Effects of altered phytoplankton compositions on the significance of nutrient and chlorophyll ratios

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Abstract

There is a clear relationship between nutrient inputs and subsequent chlorophyll increase, leading to a primary producer shift towards phytoplankton during eutrophication. Despite reduced nutrient inputs, chlorophyll concentrations of lakes, lagoons and even ocean basins are still increasing. These hysteretic effects pose a challenge to our understanding of how nutrient and chlorophyll concentrations and the underlying mechanisms are related. Causes can be for example changing phytoplankton species compositions. We observed such developments at the southern Baltic Sea coast, an area with reduced nutrient point sources, but accumulated nutrient legacies in the catchment area. We hypothesized that these compositional shifts may have been caused by resilient phytoplankton communities that are physiologically acclimatized to low nutrient levels mediating growth by exploiting diffuse nutrient inflows across ecosystem boundaries. We used short-term growth, fertilization, and enzymatic assays to analyze the mismatch of close-to-determination-limit dissolved nutrients vs. high standing stock of phytoplankton biomass. Furthermore, long-term patterns on nutrient inputs through point and diffuse sources were evaluated. We found that systems with especially high N:P ratios (up to 50:1) were dominated by picophytoplankton, which in turn was not solely P- but co-limited for N. Fertilizing samples from the mid of the water body stimulated growth only close to point sources. Contrary unfertilized samples could grow at the land-water contact zone without point sources nearby. Furthermore, the phytoplankton community accessed organic nutrient pools through enzymes depending on external nutrient availability. We concluded that traditional nutrient and chlorophyll ratios failed to explain the ongoing phytoplankton dominance. However, monitoring of organic nutrient pools, or high-throughput enzymatic assays may be a viable option for state agencies to distinguish apparent from real nutrient limitations. Targeted restorations measures could be formulated based on combined physiological and long-term monitoring assessment of nutrient limitations.

Keywords

nutrients, phytoplankton, eutrophication, monitoring

O42.4

A new method to assess eutrophication status in transitional water systems. First application in Venice lagoon

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Abstract

As in most of the coastal wetlands worldwide, starting from the 2nd half of XX century Venice lagoon suffered from eutrophication, mainly due to industrial development and changes in the land use. In the last decades, several measures were implemented to reduce nutrient inputs from the watershed and ecological restoration projects took place or are ongoing.

In this work, a new multi-metric method, developed for the eutrophication assessment in Italian lagoons, is applied to evaluate the changes occurred in the Venice lagoon in the period 2011-2019, using data collected in 30 stations within the framework of the monitoring program of the ecological status in accordance with the WFD, financed by Veneto Region.

The method includes two main steps: 1) the assessment of the quality status by selected WFD indicators [Macrophyte Quality Index (MaQI), Dissolved Inorganic Nitrogen and Orthophosphate concentration]; 2) the application of the Transitional Water Quality Index (TWQI), in case of mismatching between the biological and physico-chemical classification in step 1. The TWQI integrates main causal factors (N and P concentrations), key biological elements (chlorophyll-*a* as proxy of phytoplankton, benthic phanerogam and macroalgal coverages) and indicators of effects (dissolved oxygen saturation) of eutrophication.

During the period 2011-2019, the overall quality status of the sampled stations constantly increased with “non eutrophic” class representing 40% (cycle I), 50% (cycle II) and 63% (cycle III) of total. The stations classified in “mesotrophic” state decreased from the 50% of total during cycle I, to the 13.3% of stations sampled in cycle III. Eutrophic status of sampled stations varied according to their location, with the worst conditions mostly found in the inner areas more influenced by watershed inputs, with values ranging from 10% (cycle I) to 23% (cycle III).

Keywords

Eutrophication , Ecological Indicators, Venice lagoon, Water Framework Directive

O42.5

A Machine Learning-based approach for the assessment of eutrophication processes in the Venice Lagoon

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Abstract

Eutrophication is one of the main processes leading to water quality (WQ) deterioration (e.g. proliferation of algae) in environments characterized by stationary water, resulting in cascading effects on the environmental status of natural ecosystems and their capacity to flow services for human wellbeing. Understanding and modeling these processes can be beneficial for both integrated water resources management and sustainability, as required by the Agenda 2030 and the relevant EU acquis (e.g. Water Framework and Marine Strategy Framework Directives).

With the increase in volume, variety, and velocity of spatio-temporal data for environmental applications, and the latest advances in hardware and computer science, Machine Learning methods have started to be widely applied for analyzing eutrophication-related issues, overcoming limitations posed by traditional in-situ measurements. Drawing on these advancements, an Artificial Neural Network-based model, integrating data from monitoring stations, was designed and implemented for the analysis of changes in the Chlorophyll-a (Chl-'a') values used as a proxy indicator of eutrophication processes in the Venice lagoon case study. According to the spatio-temporal resolution of the data available for the testing case, the proposed Multilayer perceptron (MLP) model was trained, validated and tested taking into account 575222 WQ parameters' observations (e.g. Chl-'a', dissolved oxygen, turbidity), monitored across ten stations located in the Venice lagoon, over the 2013-2018 timeframe.

The performance of the designed MLP model in estimating Chl-'a'variations against the input data increased during the learning process with a final ~76% of prediction accuracy during the testing phase, making it ready for the simulation of potential '*what-if*' scenarios (e.g. climate scenarios with increasing water temperatures). Despite constraints posed by input data, the designed MLP model represents a useful tool to identify key drivers of deterioration of natural ecosystems, supporting decision makers in the achievement of environmental and sustainability targets.

Keywords

Machine learning, Eutrophication, Multilayer perceptron, Venice Lagoon

O42.6

Modelling eutrophication processes in the Venice Lagoon: a multi-hazard approach exploiting machine learning capabilities.

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Abstract

Eutrophication is a worldwide environmental problem affecting the health of close and semi-close water bodies as lagoons, lakes, and estuaries. The ecological and environmental state of water ecosystems is increasingly threatened by cultural eutrophication, i.e the excessive plant growth resulting from nutrient enrichment due to human activities (e.g. urban and agricultural waste and runoff), a process further exacerbated by simultaneous changes in water temperature, and turbidity. A multi-hazard approach is then required to understand and model spatio-temporal changes in water quality, accounting for the complex interactions among natural and human-made pressures.

To this aim, a multivariate machine learning-based Long short-term memory (LSTM) algorithm integrating ecological, chemical, and physical data, was applied in this study to model Chl-a concentration, used as a proxy indicator of eutrophication processes in the Venice Lagoon case study. Specifically, half-hourly water quality (e.g. OD, salinity, and turbidity) and hydro-meteorological data (e.g. precipitation and river flow) for the 2008-2019 timeframe were used to train, validate and test the LSTM models developed for each of the 7 monitored lagoon water bodies.

Results from the case study showed as the LSTM model successfully captured Chl-a trends under a multi-hazard perspective accounting for changes in multiple concurrent parameters. In particular, models developed for water bodies with few missing data showed very good performances (best RMSE=0.774) with also high capability to capture Chl-a extreme low and high values.

The proposed Machine Learning-based multi-hazard model represents a valuable approach to strengthen eutrophication modelling and management, which could be a significant advantage for the design of effective strategies aimed at preventing transitional ecosystems' deterioration. Moreover, the designed model is a promising tool, ready for *'what-if'* scenario analysis accounting for changes in climate conditions and urban development.

Keywords

eutrophication, climate change, machine learning, multi-hazard

O42.7

Food web structure reflects eutrophication pressure in two lagoons of the Southern Baltic Sea

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Abstract

Excess of nutrients from anthropogenic origins causes eutrophication in coastal waters and shifts the dominance from benthic macrophytes to pelagic primary producers. Decline of benthic macrophytes increases sediment re-suspension, lowers habitat stability for inhabitant flora and fauna and alters the availability and composition of living and detrital food sources fuelling the food web. How primary production enters and is channelled through the food web is already altered at early stages of eutrophication, when decline of benthic macrophytes is still reversible. The study quantitatively compared the macrozoobenthic food webs in two shallow lagoons, the Darß-Zingst Bodden chain (eutrophic) and the West-Rügensche Bodden (mesotrophic) of the Southern Baltic Sea. Food web structure was assessed by metrics proposed by Layman et al. (2010) based on carbon and nitrogen stable isotope analyses. The complexity of the food web was lower in the eutrophic lagoon than in the mesotrophic lagoon. Primary consumers in the mesotrophic lagoon had a greater spread along the carbon axis indicating a more diverse diet and higher niche diversity. The more homogenous isotopic composition of the consumers in the eutrophicated lagoon suggests strong overlap in diet composition. These findings indicate that food web structure is a sensitive indicator for eutrophication pressure and should be implemented in coastal water management.

Keywords: ecosystem functioning, submerged vegetation, trophic interaction, transitional waters

Keywords

ecosystem functioning, submerged vegetation, trophic interaction, transitional waters

O43.1

Single-agent adaptation modelling in a coastal city using the VIABLE framework

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Abstract

We develop a single-agent-based model in Netlogo of a coastal city facing climate change. The VIABLE agent-based modelling framework offers a unique approach to modelling the adaptive decision-making of agents with limited capacities and resources in socio-natural systems. We apply this framework to the context of a coastal city, managed by an urban planner, faced with climate change-induced sea level rise and related hazards. The urban planner uses capital generated by the city to mitigate these damages by investing into one of two adaptation options: developing coastal defences or relocating the vulnerable coastal territories of the city inland. As the simulation progresses, gradually rising sea levels and randomly occurring extreme sea level events incur damages, and the planner alters application of investments to optimize own value, resulting in dynamic adaptive behaviour. We track the response of this planner to the changing system through its investment patterns, and assess how successful these adaptation pathways are at mitigating damages across various scenarios.

Keywords

coastal city, climate adaptation, agent-based modelling, coastal climate services

O43.2

The application of Geographic Information System (GIS) as a water resources management tool to effectively communicate science and qualify the decision-making process in the Guanabara Bay Watershed

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Abstract

Introduction

A Geographic Information System (GIS) can be used as a tool to communicate science, qualify the decision-making process and empower change. Thus, this paper points the results of using GIS and the value of spatializing available data to be applied in the strategic choice approach in the context of the Guanabara Bay Watershed, through the Atlas of the Hydrographic Region V. The development of thematic maps is an initiative to promote communication of scientific data and information about water related issues and the social environmental status of the aforementioned bay. The objective is to develop a tool to capacitate, educate and raise awareness over the efforts needed for a technical and high-performance water resources management approach.

Methods

The maps to depict water management related issues were developed using available shapefiles from federal and state agencies involved in environmental management and data collection in Brazil. SIRGAS 2000 and UTM 23S were used as coordinate reference system and projection, respectively.

Results

The authors of this paper will investigate the impacts of the Atlas as a tool to synthesize, contextualize and make scientific data and information visually pleasing, so it can be accessible for any public and stakeholder. The Atlas was published on the World Water Day 2021 and, for future action, the efforts will be focused on sectioning the document into more detailed reports by sub-regions and catchment basins, to be used as a specific and local decision-making tool.

Discussion

Due to the legal attributions of a Watershed Committee, they play an important role in the water resources management system in Brazil. This paper provides an insight into participatory management and how georeferenced information facilitates and enables better training for committee members and others stakeholders, improving the decision-making process to protect the resources and to secure water for future generation.

Keywords

Guanabara Bay, Watershed, Atlas, water resources management

O43.3

Are endogenic managed pressures really managed or do they become endogenic unmanaged residual pressures?

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Abstract

Operationally, human activities and their pressures are managed through a system of regulatory and non-regulatory frameworks such as regulations, license conditions, standards, guidelines, and codes of practice. These technical measures are implemented as controls, procedures, and tasks that are operated by those working in very specific operational contexts of given sectors. As such, these are considered as endogenic managed pressures. However, the effectiveness of these technical measures are seldom fail-proof in reducing the pressure to an absolute zero. Unless an activity is completely avoided, any technical measures will result in a residual pressure that, combined with other residual pressure, become endogenic unmanaged residual pressures. This presentation discusses the need to study the effectiveness of technical measures that are most often attached to regulatory or non-regulatory approvals. A contrast is drawn between effectiveness of management strategies in addressing environmental objectives and the effectiveness of technical measures in producing operational expected outcomes. It is considered as a key aspect for the development of management strategies to address cumulative effects.

Keywords

residual pressures, effectiveness, technical measures, cumulative effects

O43.4

An integrated GIS-based approach to improve fish migration within the Greater Thames Estuary

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Abstract

In the United Kingdom, river restoration and intertidal habitat enhancement works are completed in an opportunistic way: when specific damages from developments need to be mitigated or when flood asset management must be addressed. Similarly, fish migratory barriers such as weirs are only dealt with as and when opportunities arise and usually only one barrier at a time. As a result, many flood asset or land development projects can miss opportunities to deliver environmental enhancement works.

To address this issue in the Thames River Basin, the Roadmap was developed that focuses on a whole-system approach and looks at rivers as interconnected migratory routes. Rivers were classified as 'Highways', 'A-roads' and 'B-roads', and after gathering information on existing migratory barriers, the extent of river fragmentation was visualised and connectivity was calculated. Then, the collated barrier data and river connectivity layers were integrated into an interactive mapping application along with data on fish species, flood risk areas, development opportunity areas and riverine/marine habitat areas.

The resulted GIS application enables the visualisation of barrier locations and river network connectivity in entire catchments. The application also allows the different datasets to be overlayed, and with the use of an in-built filter widget, the barrier, habitat and the fish species data can be filtered. This can help pinpoint those barrier locations where, for example, the upstream river sections have high quality habitats but fish passes are not installed, or where riverside developments are planned and mitigation works could be carried out to help improve connectivity.

The Roadmap is both a method and a GIS tool that helps stakeholders to understand the extent of river fragmentation. It can help make data-driven decisions and develop an integrated approach when sustainable restoration works are carried out, and it can also help build relationships across the freshwater-marine boundary.

Keywords

fish, migration, roadmap, GIS

O43.5

An Integrated Approach to Coastal and Marine Management Analysis and Solutions

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Abstract

The concept of integrated (multidisciplinary) coastal zone management (ICZM) has been proposed for some decades, but the underpinning science knowledge and data inventories, together with practical applications, have been slower to evolve. One of ICZM's key principles 'adaptive management' is a flexible 'learning by doing' approach. Here we propose an approach that builds on the ICZM heritage and core principles, and uses natural capital and ecosystem services concepts, together with additional features of pluralism and precaution. Within this transdisciplinary approach, integration is required across four disciplines (natural and social sciences, economics, arts) as well as engaging with stakeholder perspectives. Our approach utilises the Balance Sheet Approach (BSA) and comprises both a process and a set of tools. The BSA process entails contextualisation of the spatial scale, the institutional environment and the social dimensions of a natural capital problem. This process also identifies the appropriate questions and tools and how to use them to analyse the problem and find solutions. The BSA has previously been applied successfully in the Baltic but the proposed approach here involves a much deeper and more informative analysis. It can incorporate and structure a range of existing models and evidence on coastal and marine resources. This evolves the BSA from a generic framework to a specific coastal-marine decision support system addressing problems in a specific location. This can include consideration of distributional issues and equity in the trade-offs that arise in 'wicked problems' such as coastal and marine management, where existing sector-specific techniques fail to provide whole-system perspectives. Hence, this approach integrates existing elements to produce holistic assessment and provide a framework to reconcile the oft-disparate results from techniques applied independently of each other.

Keywords

Trade-off, Management, Integrated Assessment

O43.6

Is the English system of estuarine management fit for purpose?

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Abstract

Do we need to rethink our relationship with water? When managing water do we need sustainability assessments to focus on overall value and not just the cost benefit? Would estuarine management be improved if relevant sectors were better integrated and there was more of a holistic focus? Would reconnecting relationships between our environment, industry and our communities make estuaries more resilient than vulnerable? The current state of estuary management in England is fragmented and siloed. How can this be improved?

The ecological state in an estuary, and hence ecosystem services, is largely shaped by its interaction with land use, navigation, connecting river and coastal water, as well as contamination from intentional and unintentional discharges (Haasnoot and H.Middelkoop, 2012; Supriya et al., 2018; Subhasis and Qiu, 2016). Water management must, by definition, include consideration of coherent whole land-water system management, with an appreciation of the form and function of 'blue & green' natural capital and its 'grey' (man-made) capital components and how these interact (Thi et al., 2011). Interaction with human activity, largely determines the morphology of the estuary, any encroachment and how water becomes contaminated, or is cleaned and how water flows through or is retained in the landscape - with implications for pollution, flooding, coastal erosion (Depietri and McPhearson, 2017; Royal Society, 2020). We need to consider the 'natural' environment along with the functioning of the human uses demands and behaviours of water users and how these interact as a system.

Can integrating environmental data, reforming policies, and integrating policy and management efforts, improve estuary management? What do you need to manage an estuary for ecological function and societal benefits? What are the impediments to integrating management and what evidence is needed to support policy implementation of sustainable estuarine management in England?

Keywords

estuary, sustainable management, system approach

O43.7

Science and tourism development conversing ankle-deep in estuarine mud: the makings of an ecosystem-based approach to the strategic planning of a major coastal tourism project in Tróia, Portugal

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Abstract

This contribution presents an overview and discusses the added value of the close collaboration, ongoing for more than two decades, between a multidisciplinary research team and the promoter of a major coastal tourism resort in a sandy peninsula in SW Portugal.

The collaboration started in 1997 when the project was beginning to make the headlines, when the researchers invited the CEO of the economic group (SONAE) to visit a pristine tidal coastal lagoon where there were plans to build a large marina. At low tide, ankle-deep in estuarine sandy-mud, the researchers explained and showed to the promoters the costs of building and maintaining a marina in such an intertidal environment and the added value of preserving that ecosystem in its pristine shape, home to the last remaining salt marsh in that area, and to thousands of wintering aquatic birds: other than securing key ecosystem services, that option could attract a steady flow of avid birdwatchers in the low season of the main sun-sea (summer) tourism product.

This field trip set the stage for a long-standing close dialogue and collaboration between the research team and the promoter in what became the first tourism project in Portugal developed upon environmental information since its inception (first Strategic Environmental Assessment (SEA) of the kind in Portugal, prior to SEA legislation). It constituted an approximation to an ecosystem-based approach to coastal planning and management, based on the preservation and valorisation of the natural capital of this stretch of the peninsula, which resulted in significantly fewer tourism beds than allowed, reducing construction and preserving sensitive areas such as frontal (primary) dunes.

This science-tourism collaboration is an example of a win-win-win situation: for science (environmental monitoring, scientific production); for the developer (product differentiation; eco labels); and for the environment and society at large (protection of natural capital).

Keywords

ecosystem-based management, strategic environmental assessment, stakeholder dialogue, collaborative approaches

O43.8

Characterizing and categorizing reef passages in the South Pacific

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Abstract

The importance of coral reefs for Small Island States in the tropics has long been undisputed. Healthy and protected reefs help island systems (cultural, ecological, social, physical…) thrive and survive. Reef passages (RP) are home to an exceptionally diverse and abundant marine life, and they connect the open ocean to sheltered lagoon and coastal areas, with implications for ecosystems and human populations. The social and ecological roles of RPs provide multiple benefits for the islands and their peoples, but are so far poorly characterized and recognized in their own right for their multi-faceted significance. Every day, living and non-living, human and non-human objects 'pass' through these openings in various ways. This can be sediments from an island's hinterland, returning fish in spawning mode, predators such as sharks, or fishers. RPs are like 'communication zones' between inshore coastal and open waters and showcase a number of transboundary issues that need to be better understood, e.g. for conservation planning, supporting fisheries and/or protecting marine biodiversity. We used GIS-based visual interpretations of satellite imagery to find criteria for a first categorization of RPs, including parameters such as number of passages per island, passage width and depth, distance from coast or rivers. We provide a first definition of 'reef passage', and define three first categories, related mainly to their distance from the coast. For the seven selected islands in Fiji, New Caledonia and Vanuatu, a high abundance of 115 RPs was found, for which we look at some individual and overlapping characteristics and discuss how the categorization could evolve. Thereby, the study recognizes the incredible diversity of life that live from, live at, visit or just pass through RPs, highlighting the complex interactions and benefits they stand for/produce, being of ultimate relevance for local management perspectives, challenges and opportunities.

Keywords

reef passages, islands, South Pacific, marine biodiversity

O44.1

Managed realignment scheme effectiveness of saltmarsh vegetation to attenuate wave energy using remote sensing

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Abstract

It is evident that climate change is expected to impact humans and the environment, in particular, in coastal regions around the world. Coastal flooding is a common concern in coastal management and planning, for example, in the UK. It is recognised that Natural Flood Management (NFM) is a relatively novel and suitable alternative to deal with coastal flooding which uses processes found in nature, for example, using saltmarshes. This type of coastal wetland is known to provide wave energy dissipation, mainly, by their vegetation. In the UK, managed realignment is the most common technique that uses saltmarshes. The aim of this research is to explore how effective are managed realignment schemes in attenuating waves of coastal flooding based on their vegetation in terms of Leaf Area Index (LAI) and monitor this function over time using remote sensing to enhance coastal management strategies. The objectives are (1) To determine the extent to which Sentinel-2 imagery can be used to retrieve saltmarsh LAI (green and brown LAI) as an indicator of wave attenuation, (2) To determine how much saltmarsh LAI significantly vary from flowering to senescence seasons whether being a stable parameter of wave attenuation and (3) To find out how similar are man-made managed realignments versus natural saltmarshes in terms of LAI and determine the implications of this for future schemes developed for flood control by wave attenuation. Remote sensing techniques are becoming more useful and cost-effective innovations to monitor wetland environments. By doing this assessment of the wetland function of flood control, more scientific evidence will be available to increase awareness and enhance future managed realignments in the UK to deal with coastal flooding in the current climate change context.

Keywords

Flooding, Remote Sensing, Saltmarsh, Wave Attenuation

O44.2

Species-specific advantages of mangroves growing at intertidal zones

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Abstract

Restoration of degraded mangroves is important to maintain sound ecological system.

In a typical mangrove rehabilitation program, only single *Rhizophora* species is planted due to its higher survivability. It often produces a monoclonal forest with low biodiversity.

Field sampling was conducted in the Olango island of the Philippines, where *Rhizophora stylosa*, *Avicennia marina*, and *Sonneratia alba*, majorly grow at intertidal zones, which are inundated once or twice a day. *R.stylosa* was planted in a part of the area, which then covered more than 90% of the area.

Three of each species were selected at each sampling location with different elevation. Tree height, girth length, leaf surface temperature, and solar intensity were recorded, then, chlorophyll fluorescence (Fv/Fm) of leaves were measured to observe the stress condition.

The surface sediment dries up within 1 hr after the exposure to air, however, the sub-surface layer (~0.3m deep) remains wet until next high tide. The tidal front advances quickly on the ground surface, wetting the surface soil completely. Regardless of species and tree height, Fv/Fm values varied following the tidal condition; it gradually decreased after exposed to air in low tide, then, quickly increased in the rising tide.

Among species, Fv/Fm values of *A. marina* declined relatively fast until very low level, but, *R. stylosa* always maintained high values even during low tide period. *A.marina* has low stature, ascending on the ground surface. *R.stylosa* and *S. alba* are, on the other hand, erect upwards. The root depths were, therefore, ~0.5 m for *A.marina* and 1 ~2 m for *R.stylosa* and *S. alba* in the present site. Thanks to the long root, *R.stylosa*, had a high advantage to maintain favorable condition and dominated the intertidal sites. Care must be taken in the selection of species and sites for plantation.

Keywords

mangrove plantation, Rhizophora stylosa, chlorophyll fluorescence, intertidal zone

O44.3

Restoration of abandoned shrimp ponds and mangrove forests through mangrove planting in southern Thailand

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Abstract

Introduction: Mangrove forests are widely distributed in 128 tropical and subtropical nations and territories. Mangrove ecosystems provide an array of essential ecosystem goods and services, which contribute significantly to the livelihoods well-being and security of coastal communities. Mangroves are recognized as an important ecosystem in the context of national and global development and environment objectives, including the 2030 agenda for sustainable development. Mangrove forests were targeted to develop to aquaculture, agriculture and industrial area, especially in Southeast Asia countries. During the past 40 years, the forest area in Thailand has significantly reduced by the concession for unethical timber trading and land conversion to aquaculture and agriculture areas such as shrimp ponds, industrial area, and palm oil plantation.

Materials and methods: The mangrove planting project ***"The Green Carpet"*** had started to rehabilitate abandoned shrimp ponds and degraded mangroves at Nakhon Si Thammarat in southern Thailand since 1997. Over 8 million mangrove seeds were planted in the area approximately 1,500 ha. 70 fishes were caught and collected from Pak Phang Bay at Nakhon Si Thammarat. All fishes and three mangroves were analyzed as stable isotopes (^{13}C and ^{15}N) in samples for food web study by Stable Isotope Mass spectrometer.

Results and discussion: (1) R**e**habilitated mangrove areas is accumulating carbon into above ground biomasses, below ground biomasses and soil. It produces a very high level of biomass. And there is huge amount of carbon surround them and produce very high level of biomass. Mangrove forests can store around 1,000 Carbon ton/ ha in biomass. Its amount of 25 years old mangrove forests is 5 times higher than tropical rain forests.

(2) Results of stable isotopes (^{13}C and ^{15}N) study in fishes was suggested that food web of rehabilitated mangrove areas is returning to rich biodiversity environment condition through mangrove planting.

Keywords

mangrove planting, rehabilitation, food web, resoration

O44.4

Community driven portable breakwaters for mangrove rehabilitation

Sindhu Sreeranga, Hiroshi Takagi

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Abstract

Mangrove rehabilitation is a serious concern in both developed and developing economies. The success rate is still not in the acceptable range and often collapses in the early stage of plantation due to various hydrodynamic influences in shallow coastal waters. To study the root cause, field surveys were conducted in the mangrove forest of Amami Oshima, Japan, in May and December 2019. The study aims to relate ecological and engineering principles with community engagement to advance mangrove rehabilitation programs. The evolution of young mangroves was studied by planting *Kandelia obavata* seeds in Amami and laboratory. Plants grown in the laboratory were lesser in height with fewer leaves when compared to the native mangroves of Amami. A one-month-old mangrove plant was bent and submerged for two min continuous wave (10 cm height) impacts, whereas the six-month-old plant was found to be stable as observed in Amami. Therefore, a community-based portable reef is proposed to safeguard young mangrove plants from waves during the early stages of their growth. Based on field observations, a simple and economical reef was designed using Ahrens formulation. The effectiveness of the reef was further examined by performing the numerical simulations using olaFlow/OpenFOAM. Various geometrical designs were tested for local waves and tidal conditions of the Amami mangrove forest. Wave heights of 0.1, 0.2, and 0.3 m, wave periods of 2, 3, and 4 s, and water depth corresponding to varied tidal levels 0.2, 0.3, 0.45 m were considered for computations. The numerical results showed that the reef can attenuate the wave heights by 48-82%. Although wave transmission varies depending on the geometry, a small rubble mound reef of 1 m^2 cross-section and 0.4 m crest height, constructed with 15-kg stones is sufficient to protect mangrove plants in their early growth phase.

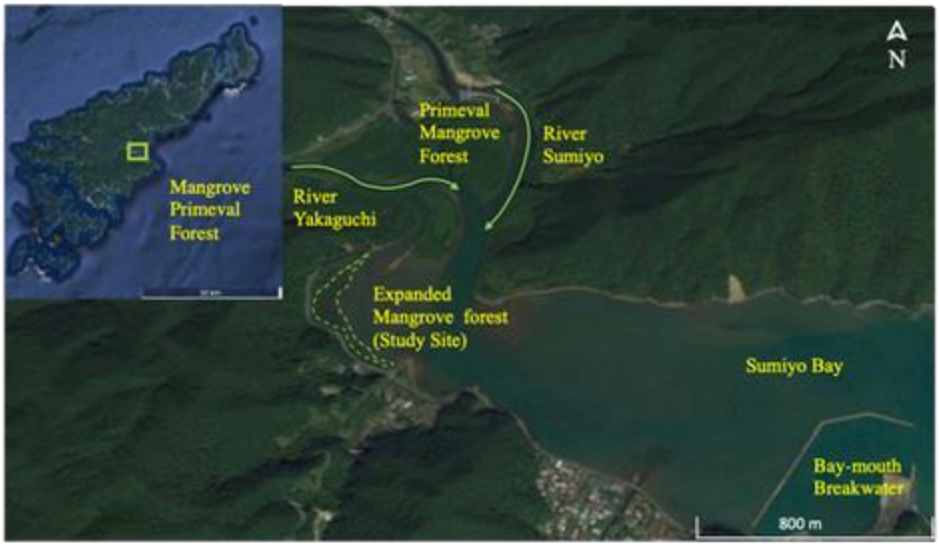

Figure 1: Research Site located near Sumiyo Bay at Amami Oshima, Japan. (Location: 28°14′57.3″ N 129°24′24.8″ E)

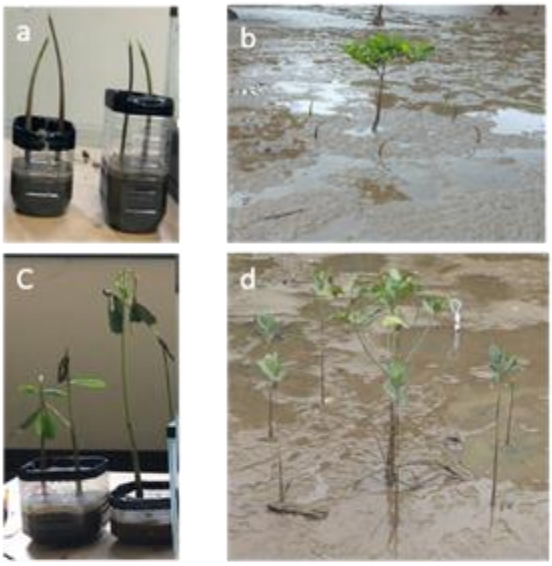

Figure 2: (a) Mangrove seedlings planted at laboratory in May 2019, (b) Mangrove seedlings planted at Amami in May 2019, (c) Seven months old mangrove plants grown in the laboratory (December 2019), (d) Seven months old mangrove plants at Amami (December 2019).

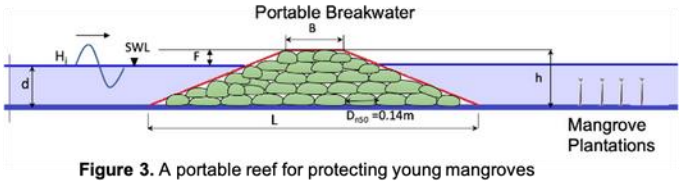

Figure 3. A portable reef for protecting young mangroves

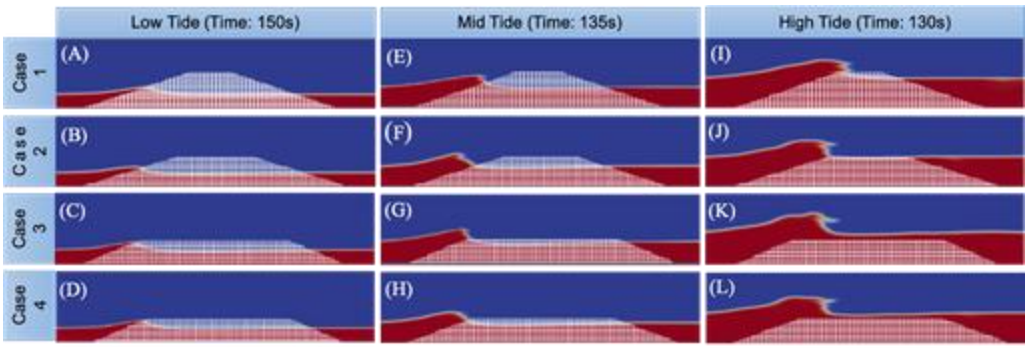

Figure 4. 2-D numerical simulation over portable reefs with a porous body **(A-D)** wave transmission during low-tide condition **(E-H)** during mid-tide conditions, **(I-L)** during high-tide condition for 4-s wave-period case.

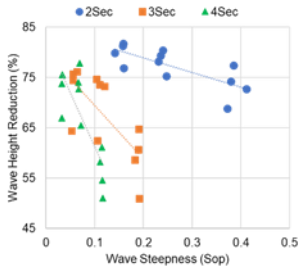

Figure 5. Wave height reduction vs wave steepness

Keywords

Young Mangroves, Portable Reef, Amami Oshima, Olaflow

O44.5

Integration of fishers' local knowledge in mangrove research and conservation in the Galapagos Islands

Jose Ponton[1,2], Nicolas Moity[3], Jorge Ramirez[3], Maria Jose Barragan[3], Gabriela Rodriguez[3], Mireya Pozo[4], Nathaly Ramirez[4], Gabriela Navarrete[5], Rafael Bermudez[2], Peter Goethals[1]

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Abstract

Mangroves are highly productive coastal ecosystems providing goods and services to humans, but also to marine species, many of them of fishery importance. In the Galapagos Islands, although mangroves cover around 35% of the coastline, in most locations, they only exist in an underdeveloped state. Yet, the importance of mangroves for fisheries production has been recognized in economic terms, even though there is still little scientific evidence about mangrove-fisheries linkages in the Galapagos. In such regards, fishers' ecological knowledge (FEK) could be a suitable approach to complement mangroves' science and management knowledge, and to guide decision making in mangrove conservation. To explore FEK about mangrove-fisheries linkages, we conducted 35 in-depth interviews to fishers from the three main ports (Santa Cruz, San Cristobal e Isabela), and contrasted and validated the information with interviews conducted to a group of 33 experts, including tour guides, park rangers and local scientists. Most fishers recognized mangrove ecosystem services, and past and current threats, and were able to propose conservation measures. Most relevant FEK includes, knowledge about fishery species' associativity to mangroves (e.g., *Mycteroperca olfax*, snappers, mullets), and habitat use (e.g., nursery habitat, refuge), and the identification of important sites (e.g. mostly in Isabela). Experts' responses, in general, allowed us to validate FEK, although more emphasis was given to the value of mangroves for non-commercial species (e.g., sharks) and tourism. Future steps involve the conduction of community workshops with fishers in two islands, in order to validate ambiguous information, and to explore new insights about mangroves-fisheries linkages. In addition, the conduction of a roundtable with mangrove decision-makers, will allow us to evaluate the integration of FEK and perceptions in mangrove research and conservation of the Galapagos Islands.

Keywords

mangroves, fishers' ecological knowledge, fisheries, Galapagos Islands

O44.6

Micro-climatic and hydrological indicators of the influence of *restorated* mangroves in Guyana

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Abstract

Entire Guyana's coastal area which extends for 430 km along the Atlantic coast with varied width of 26 to 77 kilometres lies below 0.5 metres to 1.0 meter of the mean Atlantic Spring Tide Mark. To protect the coastal boundary, a man-made sea defence system in stone wall construction (for example) was put in place. Historically, Guyana's mangrove forests have been recognised as one of the most natural forms of coastal defence, but these have been depleted due to both natural and human-induced activities. The Guyana Mangrove Restoration Project (GMRP) was established in 2010 with the main aims of promoting sustainable management of the mangroves – including but not limited to mangrove rehabilitation and replanting. Most previous evaluation of the restoration efforts has focused on the success or otherwise of the project. Contrary to other studies, this study explores the integrated influence of the mangrove restoration efforts and mangrove covers on the multiple climatic and hydrological parameters. The multi-year-averaged data analysed revealed that there is a general relationship between the development of mangrove cover and the micro-hydrological and climatic conditions in the regions where the restoration projects are implemented. Here, the yearly mangrove covering areas for the three coastal regions of the country were extracted from the USGS Landsat and Sentinel remotely sensed data from 2010 to 2020. Categorised micro-hydrological and climatic variables were also derived for each study sites. The specific hydro-climatic parameters considered in this study are temperature, solar radiation, evapotranspiration, and precipitation. Changes in patterns of micro hydro-climatic conditions were correlated with the changes in mangrove area coverages. This study confirms the positive and possible influence of mangrove project in the wider coastal area environment, not only in terms of coastal protection but in the overall influence on micro- hydrological and climatic variables.

Keywords

Mangrove Restoration, Mangrove forest area coverage, micro-hydrology, micro-climate

O45.1

Effects of benthic and pelagic biochemical processes on air-sea CO_2 flux

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Abstract

Shallow-coastal ecosystems (SCE) have the function of climate change mitigation (CCM). CO_2 gas exchange between the atmosphere and the ocean (CO_2 air-sea flux) is an important factor of CCM that constitutes a series of processes in which coastal ecosystems take up, secure, and store carbon from the atmospheric CO_2. CO_2 air-sea flux is governed by the partial pressure of CO_2 (pCO_2), and it fluctuates due to the biochemical production/consumption of dissolved inorganic carbon (DIC) and total alkalinity (TA). In SCE with high biological productivity, biochemical DIC and TA production/consumption are large in both pelagic and benthic systems, however, it is unclear how much they contribute to pCO_2. The purpose of our study is to elucidate the dominant factors of biochemical processes on the CO_2 air-sea flux from the viewpoint of the comprehensive carbon cycle in the pelagic-benthic coupled ecosystem. To achieve this purpose, we used the benthic-pelagic coupled ecosystem model (EMAGIN-B.C) describing carbon secures associated with planktons/benthic faunas metabolism, carbon storage through sedimentation/burial of carbon to the benthic system, carbonate dynamics among pCO_2, pH, DIC, and TA driven by biochemical processes. The model was applied to Tokyo bay, an urbanized SCE in Japan. As a result of analysis, if pelagic DIC biochemical production/consumption were eliminated, CO_2 air-sea flux changes from the absorption of 5.5 mol/m^2/yr to the emission of 10.1 mol/m^2/yr in average, annually. If benthic TA biochemical production/consumption were eliminated, CO_2 air-sea flux changed from the absorption of 5.5 mol/m^2/yr to the emission of 7.3 mol/m^2/yr. The main causes of the changes of pelagic DIC and benthic TA are DIC consumption by phytoplankton photosynthesis, and TA production by anoxic mineralization of benthic detritus respectively. These results suggest that DIC and TA dynamics both in the pelagic and benthic ecosystems strongly affects CO_2 air-sea flux.

Keywords

benthic-pelagic coupling, climate change mitigation, blue carbon, ecosystem model

O45.2

Innovative solutions for estuarine salt marshes restoration – An experimental study.

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Abstract

The project ReSEt – Restoration of Estuarine Salt marshes Towards Sustainability is an ongoing pilot study in the Mondego estuary (Portugal), aiming to develop innovative solutions for the protection and restoration of estuarine habitats and biodiversity. Its main goal is to test and validate applicable, sustainable and environmentally friendly techniques, assessing their application potential in management programmes. Thereby, three operational objectives were defined: 1) to test eco-engineering techniques to promote protection and long-term elevation of saltmarsh habitats – for which an experimental assay, with 5 treatments, was installed: a) control (no plants or structures); b) with plant; c) wooden palisade; d) geotextile blanket; e) geotextile bags with sand; 2) to evaluate the efficacy of plant transplantation techniques – which includes the transplantation of autochthonous macrophytes species (e.g. *Halimione portulacoides*, *Bolboschoenus maritimus*, *Zostera noltii*) from natural patches to an experimental unvegetated site using: a) direct transplantation; b) laboratorial grown cuttings; c) plant seeds. To assess the effectiveness of these techniques, ecological response was evaluated, through regular monitoring of both the experimental sites and the natural ecosystem, determining: a) sedimentation rate; b) sediment characteristics; c) water quality; d) plant coverage, density and biomass; f) diversity, abundance and biomass of macrobenthic community;. On the other hand, installation costs, technical requirements and impacts will be evaluated and estimated for future management plans implementation, considering possible “scale-up” needs. Preliminary results indicate that the tested eco-engineering solutions are increasing sedimentation and elevation of the saltmarsh, with positive impacts on the associated macrofauna. Close collaboration of multidisciplinary scientific teams with engineering companies was essential in this project, and is certainly required for the successful implementation of restoration programmes.

Keywords

restoration, estuarine salt marshes, eco-engineering, macrophytes transplants

O45.3

Identifying ecosystem services research hotspots to illustrate the importance of site-specific research: an Atlantic coastal region case study

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Abstract

The mismatch between the conceptual understanding of the Ecosystem Services (ES) in science, and their practical application, remains. Among the many issues under discussion is the link between knowledge and implementation. Base knowledge built over cases studies exist, but their usefulness for site-specific management purposes is limited. The goal of this work is to illustrate how gap analysis at the local level may contribute to the development of ES research and knowledge transfer. A review of coastal ES was performed, based on peer-reviewed journals, grey literature and other sources, allocating the information per European Nature Information System aquatic habitat coupled with the Common International Classification of Ecosystem Services. Then, a multicriteria decision-making approach was applied to find ES research hotspots, i.e., habitats for which ES research should be prioritized. Three criteria were used: abundance of ES, evidence for the supply of ES, and strength of evidence. The criteria were considered suitable for coastal areas where profound gaps in ES research exist. The Atlantic coastal region adjacent to the Mondego River was used as case study. 231 current and potential ES were listed and mapped for 21 coastal habitats. Cultural services arose as the dominant category. Saltworks emerged as the most recommended habitat for ES research. Results are in accordance with local decision-makers trends of management; we consider the approach to be appropriate as a first step towards the operationalization of the ES concept and flexible enough to be readapted to focus on critical questions that characterize ES research.

Keywords

Analytic Hierarchy Process, Mondego River, CICES, Decision-making

O45.4

Development of greenhouse gas emissions and the microbial community of a brackish water rewetted coastal peatland

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Abstract

More than 5 % of global greenhouse gas (GHG) emissions derive from drained peatlands. However, when degraded peatlands are rewetted, high methane (CH_4) emissions are frequently observed, offsetting reductions in carbon dioxide (CO_2) emissions. The promotion of microorganisms that oxidize CH_4 (methanotrophs) or sulfate-reducing bacteria that outcompete methane-producing archaea (methanogens) can lower CH_4 emissions. Therefore, rewetting coastal peatlands with sulfate-containing brackish water possibly keeps methane production at a low level. We measured CO_2 and CH_4 fluxes with transparent and opaque manual-closed chambers before and after brackish water rewetting of a coastal fen, which was formerly used as agricultural grassland. We took soil cores for microbial analysis at seven stations along a water-level gradient before and after rewetting and used quantitative polymerase chain reaction (qPCR) on 16S *rRNA, mcrA, pmoA* and *dsrB* genes to quantify the abundances of methanogens, methanotrophs and sulfate-reducing bacteria. First results imply lower amplitudes of CO_2 fluxes and remaining low CH_4 emissions even after significant increase of water levels. Once GHG fluxes are modelled to provide annual budgets and microorganisms are quantified, we will determine if the observed patterns are consistent over time and whether they can be explained by the microbial community composition. We expect an increase of methanogenic and methanotrophic archaea under newly created anaerobic conditions in addition to an increase in the amount of sulfate-reducing bacteria in previously dry sampling plots. The microbial community at sampling locations that were wet before (e.g. inside or close to a drainage ditch) should shift from rather methanogens-dominated towards organisms more associated with sulfur cycling. Overall, after rewetting, microbial functional gene abundances should show higher homogeneity along the sampling transect due to more equally distributed water tables compared to the drained state. With this study, we test the hypothesis that coastal peatland rewetting with brackish waters will reduce potential methane emissions.

Keywords

Coastal peatland restoration, Carbon storage, Greenhouse gas emissions, Microbial communities

O45.5

Composition of zooplankton communities following restauration in the Scheldt estuary and tributaries: potential of management control?

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Abstract

Introduction. This study describes how meso-zooplankton communities in the Scheldt estuary (Belgium) and its tributarieshave been changing in parallel to water quality restoration and investigates in how far these communities can be 'regulated' by management of environmental conditions.

Context and Methods. In parallel to the improving water quality in the Scheldt estuary, a colonization of the upstream, freshwater reach by the calanoid copepod *Eurytemora affinis* has been observed. Since a decade, *E. affinis* strongly dominates the meso- zooplankton community, and the originally abundant cyclopoid copepods have almost disappeared, with less diverse communities a result. Linking *E. affinis* abundance to environmental factors has shown a clear threshold effect: it can only develop at considerable abundance when O_2 concentration is above 4 mg L^{-1} and N-NH_4 concentration below 0.8 mg L^{-1}. This suggests that O_2 and N-NH_4 concentration suffice to predict a 'Eurytemora' or a 'cylopoid 'dominated community.

Problem and discussion. However, looking at 2002-2018 zooplankton monthly monitoring data from the 4 main tributaries of the Scheldt, it appears that, while there indeed exist on the one hand '*Eurytemora*' and on the other hand 'cyclopoid' type tributaries, *E. affinis* - permissive conditions do not necessarily lead to a strongly d *E. affinis* dominated community. Co-habitation also occurs. We are at present investigating what other factors than O_2 and NH_4 influence these community compositions, and if these factors are related to -and can be influenced by- management of the systems.

Keywords

Zooplankton, restoration, community composition, eenvironmental conditions

O45.6

Grasses, charismatic species, psychology, and water quality: the Natural Land Project in the Chesapeake Bay

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Abstract

In 1999, a landowner on the Chester River, a tributary of the Chesapeake Bay, partnered with university-based ecologists in an experiment to re-establish Eastern Coastal Prairies, planting native warm-season grasses over 92 hectares (228 acres), in experimental blocks with different planting regimens. Along with savannah, this was a common and wide-spread habitat at the onset of colonization in the 17th century, but has largely vanished.

The ongoing experiment continues to be a resounding success. Not only were grasses re-established, but a variety of bird species came back in large numbers. Important lessons were learned about viability, management techniques, and benefits. This success has prompted a much larger scale re-introduction of warm season grasses via Washington College's ambitious Natural Lands Project. This project is building a coalition of private and public landowners, with target restoration properties selected to ensure contiguity, critical mass, and maximum ecosystem benefit. The focus is on shoreline installations that are a minimum of 30 m (100 ft) in depth, to combine habitat restoration with positive impacts on water quality and nutrient reduction. To date, 421 hectares (1,040 acres) of grasses and 40 hectares (100 acres) of wetlands have been installed, with more to come.

This paper will address the Natural Lands Project model, sources of funding, the human factors and motivators that are keys to gaining funding and enrolling land for restoration, and planting and management techniques. An important success is a psychological shift in landowner values, with a movement away from government subsidies to non-financial rewards. Impacts in terms of reduction of sediment, nitrogen, and phosphorous will be discussed, along with data on species benefit and a more general assessment of ecosystem benefits. The design, implementation, and insights from this project offers a model for similar projects in other regions.

Keywords

Habitat restoration, Ecosystem services, Grasslands, Water quality

O46.1

Nature-based solutions for climate change mitigation: using a choice experiment approach to assess the potential of scottish saltmarshes for climate change mitigation policy

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Abstract

The carbon storage potential of saltmarshes, which is investigated in blue carbon research, has recently gained interest in the policy arena. Yet, we know little about the economic value of this carbon resource in Scotland and the social acceptability of implementing measures for its successful management. This paper investigates how the Scottish population values saltmarsh ecosystem services with a focus on the carbon storage service; and, how these values translate in terms of recommendations for best policy interventions. It aims to contribute to enabling a full realisation of saltmarshes' potential in climate change mitigation (CCM) strategies. We used a choice experiment to value saltmarsh ecosystem services by asking a representative sample of 600 members of the Scottish general public their willingness to pay (WTP) to support interventions that would maintain or improve the provision of these services. A split sample approach was used to measure the effect of information on WTP: half of the sample was randomly allocated to a treated group receiving additional information on the role of saltmarshes in carbon storage. Both groups had, on average, a positive marginal WTP for all ecosystem services presented in the survey: carbon storage, supporting biodiversity, recreation and flood defence. We found that, against our expectations, the treated group had, on average, no significantly different marginal WTP for carbon storage than the control group. This paper adds to the limited literature on the saltmarsh carbon ecosystem service. Only few studies have considered carbon storage potential in saltmarsh ecosystem services valuations. Yet, these valuations can provide important information to policymakers regarding the acceptability of future habitat management and CCM policies. Our results demonstrate the Scottish public's openness to realise the potential of nature-based CCM solutions. Consequently, there is a remit to include considerations of carbon storage in future saltmarsh management policies.

Keywords

Blue Carbon, Saltmarsh Management, Ecosystem Services Valuation, Climate Change Mitigation Policy

O46.2

An integrated conceptual model to characterize the effects of offshore wind farms on ecosystem services

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Abstract

Offshore wind farms development has become, in recent years, a key measure of the energy transition. Coastal territories are particularly favorable to the development of offshore wind farms due to their high energy potential and their high population density. However, these areas are also hotspots of biodiversity, provide attractive landscapes and are under high human pressure. Preserving the natural and cultural capital of coastal territories, facilitated the sharing of all uses, while intensifying renewable marine energies represents one of the most important challenges in the future of coastal environment. To that aim, systemic models considering all the effects of the establishment of offshore wind farms on ecosystems and society are needed. Here, we propose a conceptual model for studying these effects, by mobilizing the concept of ecosystem service in a systemic and integrated assessment approach. To do this, we identified all the effects of the construction and exploitation of offshore wind farms on food webs from a review of the literature completed by experts knowledge. Then, we analyzed the contribution of trophic compartments to ecosystem functions, ecosystem services and beneficiary and how the establishment of offshore wind farms will modify the relationships between these different compartments of the marine coastal social-ecological systems. Our approach helps identifying the causal chains generating the most important modifications in this system that may be considered in order to anticipate the impacts of offshore wind farms and to envisage management trade-offs between ecosystem services. This research illustrates the need to deepen studies relating marine biodiversity and ecosystem service relationships and to develop systemic approaches at different scales. The analysis of the effects of offshore wind farms on ecosystem services is crucial, since it is linked to strong ecological, socio-economic and political issues.

Keywords

Offshore wind farms, Integrated assessment of ecosystem services, Conceptual framework, Resource management

O46.3

Are coastal mussels affected by artificial illumination at night?

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Abstract

Artificial light at night (ALAN) was developed to facilitate people's life but continuous growth of human population and urbanisation have escalated the dissemination of ALAN. As a result, the worldwide increase of lit areas is about 2.2% annually.

This growth of artificially illuminated areas is of great concern for the conservation of organisms that have adapted evolutionarily to natural light and dark regimes for biological processes and behaviours like feeding, breeding and migration. Research thus far has identified wavelength-dependent effects of ALAN on terrestrial organisms including insects, birds and bats, and some marine species like fish, corals, and zooplankton. Because about 22% of the world's coastlines are exposed to ALAN, it is instrumental to investigate the effects of different ALAN wavelengths on more coastal organisms like bivalves.

Coastal bivalves are globally distributed, provide valuable ecosystem services, and are economically important but they may be impacted by ALAN as they possess photoreceptors, display circadian rhythms and have increased nocturnal activity and feeding.

To test the effect of different ALAN wavelengths on feeding and gaping activity, we designed an experiment exposing mussels to 12h of LED natural light and 12h of green, red and white LED ALAN wavelengths and a control dark treatment. Mussels were equipped with a custom-made system connected to a data-logger used to track the duration mussels spent open and their gaping activity. Additionally, their phytoplankton clearance capacity was recorded, and the results are currently being analysed.

Findings from this experiment can help us understand the extent to which ALAN can impact coastal bivalve populations and associated ecosystem goods and services. They will contribute towards finding the optimal ALAN wavelength that could be used for coastal illumination. This knowledge can feed into both policymaking, regarding lighting strategies, and the aquaculture sector for further optimisation of culturing techniques.

Keywords

Artificial Coastal Illumination, Bivalves, Mytilus Edulis, Ecosystem services

O46.4

The Gulf of Guayaquil the largest tropical estuary in the western Americas. Reviewing its geological and oceanographic transcendence

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Abstract

The Gulf of Guayaquil (GG) is a tropical estuarine-coastal system placed between la Puntilla (2°10'S/81°W) and Isla Jambeli (3°24'S/80°W), where the coastal margin evolution is controlled by tectonics. The origin of the GG is linking to the complex process of the subduction of aseismic Carnegie Ridge (3-km height) placed on the Pacific tectonic plate which comes beneath the South American tectonic plate, its drainage basins are>50000 km2. Around 70 % of the inland freshwater drains to the GG, with >20 rivers (400-1600 m3/s or 20 km3 y-1), or more depending on the raining season intensity and oceanographic events such as El Niño; sometimes the freshwater surface intrusion could reach the isobaths of 100 m affecting dramatically chemistry, physics, biology, and fisheries. The residence time measured in the sixties is estimated at 21 days, but it could have changed in time. The inner part of GG is feed with high concentrations of P (2-4 µM) and N (2-16 µM), while the external part (along 81W), the average of P and N averages 0.75 and 10 µM rendering a Redfield molar ratio of 13.3. The primary production in the external GG averages 0.281 kg[C] m-2 y-1 able to maintain diverse pelagic, demersal, and benthonic fisheries of around 9 million tones, for that reason GG sustains >70% of all Ecuadorian fisheries (mainly small pelagic) and aquaculture (0.6 million tons of shrimp). Through its water surface, around 20% of the GDP gets in-out because it hosts 23 ports with a load of 1.8 million TEUs and provides environmental services to >5 million inhabitants, and has huge oil-gas reserves. Nonetheless, the impact from agriculture, industry, aquaculture, mining activities, and the discharge of mainly untreated domestic waters merits prompt new research and assessment of the GG. Research lines are proposed.

Keywords

Gulf of Guayaquil, Subduction Margin, fisheries, contamination

O46.5

Developing a global economic valuation function for nitrogen impacts on coastal and marine ecosystem services

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Abstract

The ecological and economic importance of coastal and marine ecosystems is widely recognised. Yet, excessive nutrient loads into these ecosystems can lead to eutrophication, impair ecosystem services (ES), and cause significant economic costs. The estimation of the economic costs and benefits of Nitrogen (N) mitigation measures can help support policy and decision-making towards more sustainable and efficient management of the coastal and marine environment. To this end, this study reviews and synthesizes in a quantitative meta-analysis three decades of scientific research in the Baltic Sea focusing on the economic valuation of the impacts of N loads on ES provision, and the associated costs and benefits of mitigation measures. The following main research questions are addressed: i) Which ES are most impacted by N loads in coastal and marine ecosystems? ii) Which economic methods have been used to assess and value these impacts? iii) Which role have scientifically established causal pathways between changes in N loads and ES provision played in estimating the economic values of the affected ES? We combine different sources of data and information to generate meta-regression models that help explain and predict how changes in N loads change the economic values of ES in a cost-benefit analysis (CBA) framework. We start in the Baltic Sea since this marine ecosystem has been intensively studied, and is hence data rich. Recreation and water quality improvements are the most frequently valued benefits impacted by N loads in the Baltic Sea. The estimated meta-regression models are used to provide preliminary indicator values for a reduction N loads globally. Although statistically significant relationships are found between costs, benefits and N baseline and N reduction levels, location and context-specific N-indicators underpinning unit costs and benefits challenge their combined use in a common global CBA framework.

Keywords

Coastal and marine ecosystems, Nitrogen loads, Ecosystem services

O47.1

Effect of hydromorphological conditions in estuaries and coastal waters on migrations, fishing and productivity of anadromous fishes of Kamchatka Peninsula (Far East of Russia)

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Abstract

The paper based on our long-term integrated research on the Kamchatka Peninsula (the Pacific coast of Russia). The main purpose of studies is the assessment of abiotic, biotic and anthropogenic factors impact for the productivity of natural anadromous fishes populations. Kamchatka is an unique region for such study because it is a sparsely populated and wild area with very diverse natural conditions and low biodiversity of freshwater ichtyofauna (which anadromous fish species, mainly of Salmonidae family, are absolutely predominate). Natural populations of these fishes always have been the base for indigenous fisheries, and it is the basis of economy of Kamchatka region now. At the present, the total catch of anadromous fishes on Kamchatka is about 300-500 thousand tons annually (mostly Pacific salmon). This fishery is seasonal and going on mainly in the ice free season during mass spawning migrations in estuaries and the coastal waters. In that time, anadromous fishes plays a key role in the coastal, estuarine and river ecosystems and also have a most important economic and social significance for the Kamchatka people. Always been known, that the abundance of anadromous fishes in various areas of Kamchatka is significantly differs, but the reasons were not fully understood. Our studies have shown that it is could highly depend to the geographical features of the various river systems and also to the differences of environmental conditions in the estuaries and coastal waters. In this paper we would like to show, how the hydromorphological conditions in various Kamchatka coasts can impact for the distribution and migration of anadromous fishes. How this features can affect for fishing effectiveness. How fishing can affect for the reproduction and stock abundance of natural populations. How all these factors can impact for the fish productivity of different river systems. The results of our research are necessary for development of rationally strategy for the fishery management and preserve of natural anadromous fishes populations of Kamchatka.

Keywords

mixing zone, anadromous migration, commercial fishes, fisheries management

O47.2

Invasive alien species create moving baselines in water quality assessments

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Abstract

The environmental status of marine, estuarine and limnic waters is traditionally being evaluated taking into account the effects of various stressors, such as chemical pollution, eutrophication, habitat destruction and overexploitation. The assessments are based on measuring “noise-to-signal” ratio seeking to unscramble the effects of various stressors, like chemical pollution, eutrophication, habitat destruction or overexploitation. As with all such stressors, the greatest challenge in environmental stressor detection is determining a ‘signal’ of effect against a background of inherent variability, i.e. ‘noise’ thus the need to define and detect the ‘signal to noise’ relationship. The effects caused by invasive non-indigenous species may interact with other stressors or even obscure them, producing ‘noise’ in metrics used for environmental quality assessments. Such ‘noise’ may indicate a false ‘improvement’ or, vice versa, ‘impoverishment’ of environmental conditions, analogous to a statistical Type I or Type II error. The analysis shows that many environmental status indicators used to measure progress towards implementation of the European Union Marine Strategy Framework Directive (MSFD) can be modified by invasive species. Bioinvasion impacts result in alterations to biological communities, sea bed habitats, pelagic environment and food webs, thus producing shifting baselines in environmental assessments. A general scheme is proposed showing how Descriptor 2 (D2. Non-indigenous species) may be related to other MSFD descriptors, which, in turn, can be used to develop a procedure how to take into account possible impacts of invasive species on indicators in overall environmental status assessments.

Keywords

environmental assessment, Good environmental status, biological pollution effect, MSFD indicators

O47.3

New development of marine spatial planning in China: problems and policy suggestions on the implementation of Marine Main Functional Zoning

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Abstract

As a Marine Spatial Plan, the Marine Main Functional Zoning is an important strategic measure for China to implement the system of main functional zoning, and it also plays an important role in the new territorial spatial planning. Since the implementation of the Marine Main Functional Zoning in 2015, it has achieved remarkable results and played a significant role in promoting the formation of an efficient, coordinated and sustainable development of the marine territorial spatial planning. However, there are some problems such as lagging supporting policies and plans, inadequate planning implementation mechanisms, unclear zoning basis and scope, insufficient planning connectivity, lack of social awareness and public participation, etc. After the new round of reform of the national planning system, the Marine Main Functional Zoning will be integrated into the territorial space planning system, and continue to play a role of the main functional zone. Under the new situation, efforts should be made to build a plan implementation evaluation system, strengthen coordination with other plans, improve planning supporting policies, and ensure the effective implementation of the Marine Main Functional Zoning under the territorial spatial planning.

Keywords

Marine Spatial Planning, Implementation, Main Functional Zoning, territorial spatial planning

O47.4

Adopting artisanal fishers' knowledge and experiences to illustrate the implications for coastal sustainability in Northeastern Taiwan

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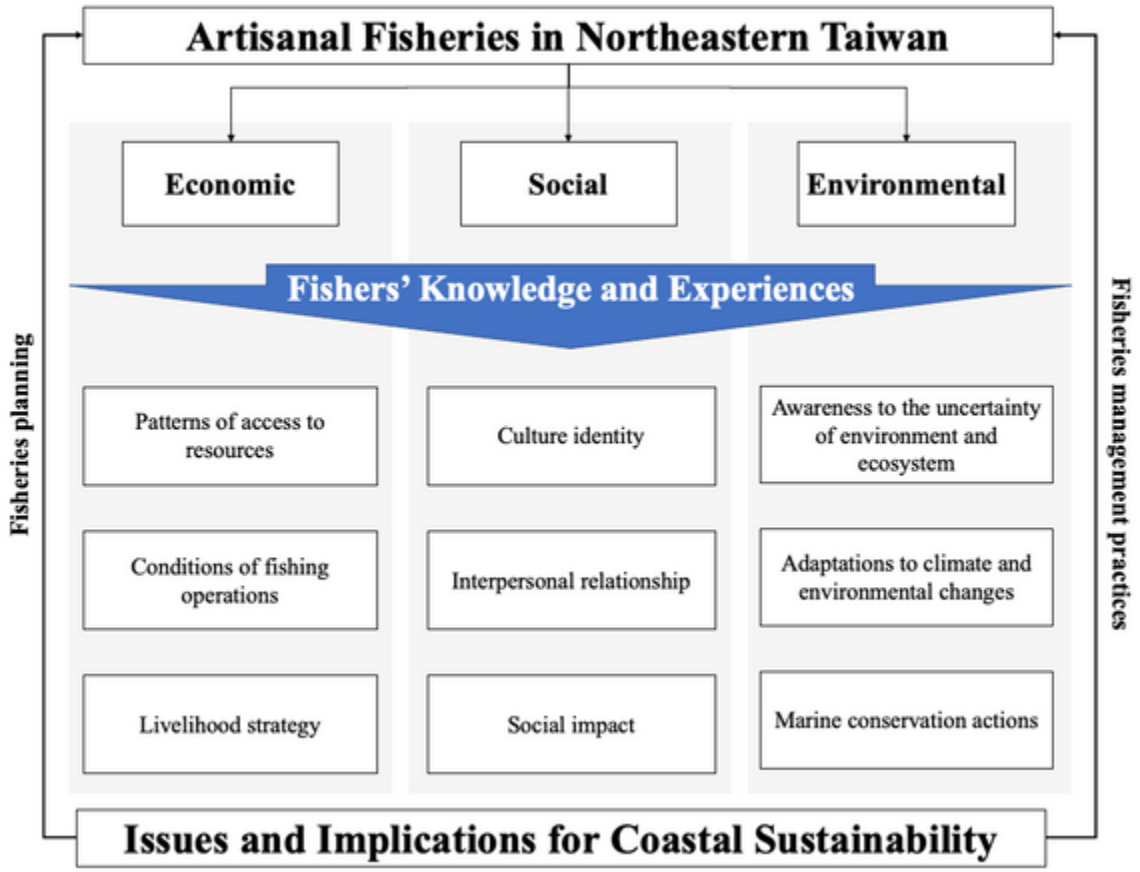
Abstract

The objective of the study is to obtain novel insights for scientific purposes by adopting local views from coastal artisanal fisheries in northeastern Taiwan. This study employed local fishers' knowledge and experiences to reveal issues and implications highly correlated between local context and fisheries sustainability. Through theory construction, a framework combined with social, economic, and environmental dimensions (with three elements in each dimension) was applied to construct the outline of semi-structured interviews. Nine artisanal fishers were involved in our interviews, then the data were coded to explore the implications for fisheries sustainability. Our findings showed that: (a) in the Economic dimension, fishers' knowledge and experiences play an indispensable role in operating the fishery among elements of *patterns of access to resources*, *conditions of fishing operations*, and *livelihood strategy*. (b) In the Social dimension, *cultural identity*, *interpersonal relationships*, and *social impact* could demonstrate the characteristic of fishers' society. (c) In the Environment dimension, *awareness of the uncertainty of environment and ecosystem*, *adaptations to climate and environmental changes*, and *marine conservation actions* could reflect the interactions between fishers and the environment. The interviews reflect the facts that artisanal fishers are expected to ensure economic stability (e.g., cost-effectiveness, regulation, production, and marketing) while confronting challenges of environmental changes (e.g., impacted by climate change and anthropogenic activities) and marine conservations which implicates issues in both economic and environmental sustainability and resilient society (e.g., cultural inheritance, cooperative behavior, and sense of cultural identity). This framework adopted for outlining the context of artisanal fisheries in northeastern Taiwan could provide valuable qualitative information from fishers' knowledge and experiences. Therefore, we suggest that there should be much more advocacy of mechanisms to combine fishers' knowledge and experiences into fisheries planning and management practices, which help us achieving Sustainable Development Goals (SDGs) 8, 11, 13, and 14.



Keywords

Fishers' Knowledge and Experiences, Artisanal Fishers, Coastal Fisheries, Sustainability

O47.5

MozamSeq: Developing capacity for eDNA-based monitoring of coastal biodiversity and ecosystem health in Mozambique

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Abstract

Monitoring marine biodiversity is labour-intensive and expensive, requiring the use of many different survey methods to obtain data on different taxonomic groups. Despite significant survey effort, data remain patchy and incomplete, which hampers effective conservation of both species and ecosystems. Environmental DNA (eDNA) can capture the genetic footprint of an entire ecosystem from a water sample, using a simple filtration kit that can be used by non-specialists, such as engineers, citizen scientists, local communities and even school children.

In this project, we investigated the potential of eDNA data for helping local communities to better understand the distribution of fish species inside and outside of community-driven Marine Protected Areas and to support the community fishing councils and authorities in deciding how best to regulate fishing activity in Inhambane Bay, Mozambique. Live video training sessions were held to instruct members of the local fishing community on how to collect and filter water samples. In total, almost 50 samples were collected during the project, and we were able to obtain good quality DNA from the filters. We detected 303 fish operational taxonomic units (OTUs) across the samples using metabarcoding, and 28 % of these were identified to species level.

We were able to validate key stakeholders' interest in such a tool and demonstrated that our kits can be used by local fishing communities and conservationists to collect high quality data on marine vertebrates for decision making and monitoring. Our findings highlighted the importance of investing in the development of DNA reference libraries to underpin accurate naming of species detected by eDNA, and the role that communities can play in collecting informative biodiversity data.

O47.6

Recreational diving impacts on marine ecosystems: contributions to sustainable management

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Abstract

The literature on diving tourism has grown at a pace almost comparable to the growth in the number of tourists/destinations. Worldwide there are scientific works focused on the impact of diving tourism on the environment, on behavioral observation and satisfaction of divers, however they are mainly focused on tropical regions usually associated with coral reefs. In subtropical/temperate regions, with specific characteristics like non-tropical rocky flora and faunal communities and other biogenic reefs, there are a knowledge gaps in this area. For instance, most of the studies addresses Mediterranean coralligenous systems and coral species as bioindicators of the impacts in marine ecosystems caused by diving tourism. In Portugal, information and research on characteristics and management of diving activity and acceptable limits of change (LAC) of the marine ecosystem is limited. This project will address adapted methodologies, diving sites carrying capacity, having as a case study the Azores archipelago (NE Atlantic) and the Algarve, being able to assist in the future better management and understanding of the activity, considered strategic for the tourist development of both regions. The investigation will include an analysis of the pressure of diving activity on ecosystems, the LAC of the ecosystem and the impact on tourist satisfaction. The purpose of this presentation is to provide the preliminary results of the first step of the study, such as: how the theme of recreational diving management has been approached worldwide; the barriers on mainstreaming the evaluation of ecological LAC into management; what knowledge gaps exist in subtropical/temperate regions with the characteristics of the case studies; what solutions were found to reach a better management of the activity industry in these regions.

Keywords

Diving tourism, Recreational diving impacts, Marine ecosystems, Sustainable management

O47.7

Challenges for restoration of estuaries: how to combine economic development with ecological restoration.

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Abstract

Loss and deterioration of estuarine habitats not only result in a loss of biodiversity but also in an enormous loss of ecosystem services. Flood risk, erosion, eutrophication,.. increased significantly and traditional coastal engineering, such as the building of sea walls, dikes and levees is seriously challenged in many places as it often exacerbates problems and hinders the natural processes maintaining coastal habitats and their build up with relative sea level rise. Recently, ecosystem-based adaptation has been brought into large-scale practice, as a solution that is more sustainable and cost-effective than traditional coastal engineering. It aims at restoring ecosystems and the delivery of ecosystem services. This concept has been applied and further developed in the Schelde estuary. The system was largely degraded due to large scale embankments and morphological changes since more than 1000 years for agricultural and more recently industrial development. On top of that water quality degraded severely from the fifties onward. Already in the sixties the first measures were taken to protect some of the remaining estuarine habitats, but these habitat and biodiversity oriented initiatives could not stop further degradation of the estuary. Despite investments in waste water treatment, water quality improvements were however limited in the tidal freshwater part of the Schelde. Nutrient loads remained high as the Schelde drains a very densely populated catchment. It became clear that an integrated restoration plan was necessary and that restoration objectives should not only be formulated in terms of restoration of structural biodiversity but also in terms of how this restoration can reduce the overall negative trends in the hydro- and morphodynamics and can enhance the ecological functioning (and water quality) of the estuary. This approach will be described and the challenges for research needed for a successful implementation will be discussed.

Keywords

ecosystem services, holistic management, restoration

P1.01

Influence of saltmarsh morphology on nekton distribution in the Venice lagoon

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Abstract

Saltmarshes are a complex mosaic of tidal creeks, pans, levees and plateaux that can play different roles as nekton habitats in transitional waters. The Venice lagoon (northern Adriatic Sea, Italy) hosts different saltmarsh systems, which originated from diverse processes and are subjected to different environmental conditions and anthropogenic pressures. This study aims at investigating the major morphological differences among marsh systems in the Venice lagoon, hypothesising how they could influence nekton distribution. Nekton and environmental data collected during spring, summer and autumn at ten saltmarsh sites located in three large sub-basins of the Venice lagoon were gathered from recent monitoring and research programmes (2013 to 2019). At each site, nekton was sampled by seine netting both in tidal creeks and along outer marsh edges, and total abundance per area unit was calculated. During nekton sampling, physico-chemical properties of water and sediment were recorded. Morphological attributes of saltmarsh sites were quantified from georeferenced aerial photographs. Spatial configuration of creeks (including creek density, fractal index and area) and marsh edges (including edge shape index and proportion of artificial marsh) was calculated. On the basis of a PCA performed on physico-chemical and morphological variables, saltmarshes from the three lagoon sub-basins separated according to creek network complexity (first PC axis, correlated with creek density and fractal index). A major sea-lagoon confinement gradient was also identified, which was uncorrelated with the morphological pattern (second PC axis, correlated with salinity, turbidity and trophic status). Total abundance inside tidal creeks showed a significant positive correlation with the first axis. More complex creek networks, such as those in the northern lagoon sub-basin, may therefore support more abundant nekton assemblages compared to simpler and less developed marsh systems. These findings highlight the importance of considering morphological attributes of saltmarshes when managing and restoring nekton habitats in coastal lagoons.

Keywords

saltmarsh, habitat, landscape, fish

P1.02

Transportation of Larvae of Iwagaki Oyster, Crassostrea nippona, in Maizuru Bay, Japan.

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Abstract

Maizuru Bay is an enclosed bay facing the Sea of Japan in Kyoto Prefecture. Iwagaki oysters, Crassostrea nippona, are farmed in this bay. Oyster larvae are harvested in one empirically known area located outside the bay. On the other hand, the amount of harvest is affected by fluctuations in natural conditions. Therefore, in order to find a new harvest area, we tried to clarify the transportation process of the Iwagaki oyster larvae in Maizuru Bay by numerical model experiments.

4 tidal components, wind effect, river discharge, water temperature and salinity are considered in numerical model. Here, the oyster larvae mainly occur in September in Maizuru bay. Then, numerical model experiments are carried out under the situation in September and the larvae are released from oyster farm.

As a result of the numerical model experiment, the following is found. The flow field in the head of Maizuru Bay has a vertically three-layer structure with inflow at the surface and bottom layers and outflow at the middle layer. In the outer region of Maizuru Bay, the density current that propagates eastward along the shore from the Yura River mouth is dominant due to freshwater discharge of Yura River located on the west side of the bay mouth. Further, as a result of larvae tracking experiment, it is found that, while most of larvae that occurred in Maizuru Bay remain in the bay, some larvae flow out of the bay and are transported to the east, where they reach the conventional harvest area at the optimal time for landing (about two weeks).

Using these results, a new harvest candidate area was selected. In this area, Kyoto Prefectural Fisheries Research Institute carried out a larva harvest experiment and same level of harvest results as in the conventional harvest area was obtained.

Keywords

Numerical model experiment, Larva tracking, Oyster farming

P1.03

Context dependent growth strategies of dune grasses

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Abstract

The formation of biogeomorphic landscapes, such as coastal dunes, is dependent on colonization by clonal plants. Dune grasses expand clonally, and their clonal expansion pattern strongly influences their ability to trap sediment. Subsequently, dune grasses with differing clonal expansion patterns have a different dune building capacity. Recently, it was found that the growth strategies of European marram grass (*Ammophila arenaria*) and American beachgrass (*Ammophila breviligulata*) could be described by different random walk processes (a truncated Lévy walk in *A. arenaria* and a composite Brownian movement in *A. breviligulata*). Besides, a mesocosm experiment showed that *A. arenaria* adaptively changed its clonal expansion from a more clumped to a patchier pattern with increasing sediment deposition. This indicates that the growth strategy of *A. arenaria* may be an indicator of environmental conditions. The hypothesis that clonal expansion strategies of dune grasses are an indicator of environmental conditions was tested in a survey along the western European coast (France to Denmark). The growth strategies of the two main dune building species *A. arenaria* and *Elytrigia juncea* (Sand couch) were determined. It was determined whether the growth strategies were context dependent and whether the inter- or intraspecific differences in growth strategies were bigger.

Keywords

Clonal plants, Ecosystem engineering, Coastal dunes

P1.04

Are growth strategies of pioneer plants in salt marshes adaptive?

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Abstract

Salt marshes are an important component of temperate coastlines providing coastal protection and a unique habitat. As other vegetated coastal ecosystems, salt marshes are shaped by an interaction between geomorphology and plants. Clonal plants such as grasses in the *Spartina* family modify landscapes through self-facilitative processes. By organizing shoots in patches these plants are thought to entrap sediments and to create protection against hydrodynamic stress. Because of these interactions, the growth strategy of grasses and their shoot placement pattern may have a direct effect on the morphology of the landscape. In a recent study, dune grasses were shown to organise shoots according to a Lévy type random walk. Furthermore, they showed that the strategy of dune grasses was adaptive to contrasting experimental environments and optimized for sand capture eficiency. Here we discuss data from a field survey across European marshes to see whether wild patches of *Spartina anglica* follow specific shoot placement strategies in different types of environments. Furthermore, we discuss preliminary results from a multi-year field experiment where wild transplants were placed in establishment structures that protect them from hydrodynamic stress. We hypothesize that *S. anglica* grown in these structures adapt their growth strategies to match a relatively safer environment.

Keywords

salt marsh, clonal growth, ecosystem engineering

P1.05

Experimental Study on Environmental Tolerance of Hard Clam in Tokyo Bay

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Abstract

Manila clam (Ruditapes philippinarum), which is a valuable fishery resource, has been caught in the inner part of Tokyo Bay. However, its production has declined year by year due to adverse marine environmental conditions, such as intermittent high temperature, anoxia, and low salinity. By contrast Hard clam (Mercenaria mercenaria), an introduced species since the late 1990s, has gradually been increasing probably because of high tolerance to hypoxia and become a fishing target in the bay. Quantitative information about the tolerance has, however, been, missing in the bay. In order to develop a clam model for sustainable fishery management, we conducted laboratory experiments on tolerance of these clams to marine environmental conditions in summer. Results for tolerance to anoxia showed that at a low temperature of 20 ℃ Manila clams died within 10 days whereas Hard clams survived for more than 60 days. The survival time of Hard clams took the minimum of around 10 days from 28 ℃ to 32 ℃; all of them died within a few days at 33 ℃ or higher. At a temperature of 34 ℃ or higher all the Hard clams died nearly at the same period under both oxic and anoxic conditions, which indicates the maximum allowable temperature was below 34 ℃. Using these results and existing knowledge in the literature, we developed a mortality estimation model of each clam considering the influence of intermittent anoxia. This model was applied to predict time series of each clam population using sets of water quality data continuously observed at multiple stations in the past few years at the head of the bay. It revealed that some of the Manila clams were killed, whose mortality was affected by the magnitude and location of upwelling of anoxic water, while all of the Hard clams survived under the intermittent anoxic conditions.

Keywords

mortality of clams, high temperature, anoxia, hypoxia

P1.06

Protein wasting and oxidative damage in the spawning land-locked three-spined stickleback due to *Schistocephalus solidus* invasion

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Abstract

Three-spined stickleback, *Gasterosteus aculeatus*, due to euryhalinity, inhabits marine and freshwater environments migrating to the coastal areas for spawning. Spawning is an energy-demanding life cycle period for any fish species, including those of a land-locked stickleback subpopulation inhabiting a freshwater lake of the White Sea basin. Besides, parasite infestation also compromises the welfare of stickleback, a second intermediate host for *Schistocephalus solidus*, via behavioral and feeding abnormalities. Both the spawning and parasite invasion exhaust fish thus threatening the spawners' viability. In order to discriminate the effects of spawning and parasites on host metabolism and the mechanisms of muscle degeneration, the protein-degrading enzymes and oxidative stress biomarkers, including carbonylated proteins and the antioxidant system, were evaluated in the organs of spawning *G. aculeatus* both invaded and non-invaded with *S. solidus.* In parasite-invaded fish, a substantial decrease in total body weight and losses of the skeletal muscle proteins were revealed. Besides, oxidative damage of tissue proteins (measured by protein carbonyls) and subsequent activation of the protein control machinery, including the autophagic and proteasome systems, were detected in the liver and muscles of infected individuals. *Schistocephalus*-induced effects on a host, such as oxidative stress and toxicity, were revealed through the induction of antioxidant enzymes, such as glutathione transferase, and low-molecular agents in fish liver. Summarizing, both the exhaustion of skeletal muscle reserves and significant oxidative damage of the vital macromolecules are involved in the mechanisms of parasite-induced abnormalities in stickleback protein metabolism. On the other hand, the mobilization of muscle protein depot and amino acid utilization in the energy production pathways maintain the individual viability of stickleback, particularly during spawning. The study was supported by the budget funding by theme 0218-2019-0076.

Keywords

spawning, three-spined stickleback, host-parasite, muscle proteolysis

P1.07

Oceanic diel vertical movement patterns of blue sharks vary with water temperature and productivity to change vulnerability to fishing

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Abstract

In the pelagic environment diel vertical movements (DVM) are widespread across taxa, from zooplankton ascending from day-time depths into surface layers at night to avoid visual predators, to apex predators following prey movements to maximise foraging opportunities. In this study, we satellite tagged adult (> 180 cm fork length, FL) blue sharks (Prionace glauca) in the North Atlantic Ocean to examine behavioural changes in response to the encountered environment, and as a consequence, determine potential risks of capture using pelagic longline fisheries data. Blue sharks displayed cyclic diel behaviour, with nighttime spent exclusively above 250 m depth and variable day-time depth use. Three different diel vertical behaviours were identified during the tracking period: (i) regular normal DVM (nDVM) (dawn descent – dusk ascent) for 55.7% of the tracking time, (ii) surface-oriented (occupation of surface waters both day and night; 22.8%) and (iii) deep depth-oriented nDVM (dawn descent – dusk ascent, with the majority (>50%) of daytime spent at depth; 17.5%). Importantly, diel behaviours generally occurred in different ocean regions with nDVM frequently observed in high latitudes, associated with cold, highly productive waters (e.g., North Atlantic Current/Labrador Current convergence zone, West African upwelling area), while depth-oriented nDVM was observed in warm, oligotrophic areas. Thus, day-time occupation of deeper waters significantly increased with higher water temperatures in the upper ocean layers (<100 m), and with increasing depth and decreasing concentration of the chlorophyll ‘a’ maximum. During nights of full moon blue sharks spent significantly more time in the depth range of longline hooks, while fishing effort and catches were also higher. We demonstrate that increased occupancy of surfacelayers driven by highly productive, cold waters and greater lunar illumination lead to higher capture risk. Understanding habitatspecific vulnerability to fishing in a commercially important pelagic shark species is essential for improving management and conservation measures

Keywords

Sharks, Fisheries, Behavioural Ecology, diel Vertical Movements

P1.08

Main anthropogenic impacts on coastal benthic macrofauna of sandy beaches: a review

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Abstract

Sandy beaches provides several ecosystem services such as coastal protection and resilience, water filtration and nutrient mineralization. Beaches also represent a hub for social, cultural and economic relationships as well as educational activities. Increasingly urbanization, recreational activities and mechanical beach cleaning represent major anthropogenic disturbances on sandy beaches due to loss of biodiversity as well as good and services. Information about the effects of human pressures on benthic macrofaunal communities could be useful to assess the environmental status of sandy beaches and to promote a sustainable use of this environment. Here, scientific articles about three major anthropogenic impacts on sandy beach macrofauna were reviewed with the aim to provide the state of knowledge about these pressures, to highlight gaps, to supply considerations about the methodologies and the used indicators and to give insights for future studies. The stressors considered in our review are: 1) trampling, 2) breakwater barriers 3) mechanical beach cleaning. This review underlined that there are few studies on human disturbance on macrofauna and the lack of enough indicator species to assess the different stressors. Similarly, the researches have covered certain specific regions highlighting the need for such studies in other parts of the world. In particular, the impacts of breakwater barriers on surrounding communities has been found to be given less attention in literature and there is enough that could be explored.

Keywords

Sandy beaches, Macrofauna, Benthic, Human impacts

P1.09

Global biogeographic patterns of harmful algal blooms: trends and hotspots

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Abstract

Harmful algal blooms (HABs) are natural occurrences, generated from the rapid growth of algae, that may negatively impact aquatic ecosystems and human health. Depending on the species, many toxins can be produced, potentially causing different illnesses, i.e. Paralytic Shellfish Poisoning (PSP), Amnesic Shellfish Poisoning (ASP), Diarrhetic Shellfish Poisoning (DSP), Neurotoxic Shellfish Poisoning (NSP), Cyanotoxin effects (CTX) or Ciguatera Fish Poisoning (CFP). These toxic events can cause morbidity and mortality in marine wildlife via direct bioaccumulation of toxins in filter-feeding organisms as well as through consumption of contaminated prey by higher trophic level organisms. Trophic transfer of toxins during HABs also presents risks to human and overall ecosystem health. Additionally, HAB events are responsible for shellfish harvesting closures, leading to major economic and sociological impacts. In the present study, we aim to identify the hotspots of the different HABs groups worldwide, and discuss patterns of bloom frequency and duration. To this end, data were collected from the Harmful Algae Event Database (HAEDAT), compiled, filtered, and standardized for the period between 1978 and 2018. This database compiles the data fed through monitoring programs worldwide by ICES and PICES member states. Preliminary results point to European waters constituting the major hotspot regarding most toxins analyzed, bearing in mind that HAB events may be underestimated in some areas of the globe. Analysis of the total number of events reported revealed that most events reported PSP occurrences, followed by DSP, with NSP occurrences being the least abundant. The results of the present work contribute to a better understanding of the dynamics, geographical distribution, and temporal patterns of HAB events globally over the last four decades.

Keywords

Harmful algal blooms, Global biogeography, Marine toxins, Spatial patterns

P1.10

Forecasting climate-mediated impacts in a HAB-inducing dinoflagellate (Gymnodinium catenatum) using species distribution models

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Abstract

Algal blooms consist in the sudden overgrowth of microscopic species under optimal environmental conditions. This can lead to the phenomenon of Harmful Algal Blooms (HABs), which are known to induce negative effects on marine food-webs (e.g. vast fish-die-offs, and oxygen depletion over large areas). Some HABs are associated with algae-produced toxins, which pose serious risks to marine life and human health. Of these, Paralytic Shelfish Toxins (PSTs) are the most abundant in oceans globally, and cause serious health-related and environmental impacts. The unarmored dinoflagellate *Gymnodinium catenatum* is a known PST producing microalgae, typically associated with stratified areas in coastal habitats worldwide, and also following upwelling events. Climate change has the potential to alter the occurrence and geographic spread of bloom-forming species, and changes in frequency, intensity, or geographical spread can lead to new and catastrophic impacts of toxic HABs. Therefore, the ability to predict the potential impacts of climate change in these species is paramount for the correct monitoring of vulnerable ecosystems. In this context, the present study employed species distribution models to analyze the present habitat suitability and species distribution of *G. catenatum* globally, using occurrence data in conjunction with environmental predictors (i.e. temperature, salinity, current velocity, and bathymetry). Afterwards, the models were used to predict their potential future change (i.e. 2050, 2100) across four representative concentration pathway scenarios (CMIP5: RCP26, 45, 60, and 85). This species appears particularly vulnerable to latitudinal shifts in habitat suitability, which can lead to more frequent and more detrimental blooms in the future.

Keywords

Gymnodinium catenatum, Harmful Algal Blooms , Paralytic Shelfish Toxins , Climate Change

P1.11

Paralytic Shellfish Toxins' production and oxidative stress response of a HAB-inducing dinoflagellate (Gymnodinium catenatum) under marine heat waves

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Abstract

Not only the global sea surface temperature is increasing and expected to increase further, but extreme events, such as marine heat waves (MHWs) are becoming more frequent, intense and long-lasting. MHWs can be described as intervals of time, where ocean temperatures are higher than usual, and can be categorized by their duration, intensity, rate of onset and spatial distribution. The duration of these events is variable, lasting between days and months.Typically, with increasing temperatures, phytoplanktonic species tend to have higher growth rates until a species-specific temperature threshold is met. Algal blooms, as natural occurrences, are defined by the sudden overgrowth of microscopic algae under certain environmental conditions. These events are beneficial to the ecosystems, unless the overgrowing species produces toxins, leading to harmful algal blooms (HABs). Among HAB-toxins, Paralytic Shellfish Toxins (PSTs) are one of the most abundant HAB-toxins in oceans worldwide. These toxins are responsible for Paralytic Shellfish Poisoning in humans, shellfish closures worldwide and detrimental impacts on marine organisms. *Gymnodinium catenatum*, a PST producer, is an unarmored, chain-forming dinoflagellate, that occurs more abundantly in Portugal following upwelling events. Within this context, the aim of the present work was to determine toxin production and oxidative stress response upon exposure to two simulated MHWs (categories I and IV). The present findings are of paramount importance for the understanding of how these bloom forming species are affected by MHWs, what potential cascading effects they can have in human health and the overall health of coastal ecosystems.

Keywords

Paralytic Shellfish Toxins, Gymnodinium catenatum, Oxidative stress , Marine heat waves

P1.12

Influence of yangtze estuary deepwater channel upward extension project on new Liuhe and ruifeng sands in nangang.

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Abstract

Water transport occupies an unshakable position in the transportation system of China, and the evolution of estuarine sandbars has a direct and close relationship with the safety of waterway transport and port facilities.Therefore, based on the water depth data of Nangang in the Yangtze River estuary in the last 10 years, the evolution process and characteristics of the new Liuhe and Ruifeng sediments are analyzed.The results show that the total net sediment volume of the reach in the study area is about 194 million m^3 from 2010 to 2013, and the total net scour volume of the reach is about 245 million m^3 from 2013 to 2019.From 2013 to 2019, the sand body above the 0m isobath of the sandbank increased by 3.91km^2, while the area within the -5m isobath decreased by 8km^2, and the overall center of mass of the sandbank body moved upward.The extension project of the Yangtze River deepwater channel has increased the sediment discharge in the upper reaches of Nangang River to some extent, which is an important source of the increased sediment accumulation in the Nangang river channel, and also one of the reasons for the increase of the area of the new liuhe and ruifeng sand.From 2013 to 2019, the increasing scouring amount of Nangang channel reduces the enveloping area of -5m isobath line and causes the swing of the deep depth line of the channel, which has an important impact on the transportation safety of the Nangang channel.

Keywords

Yangtze Estuary, new liuhe sand, ruifeng sand, nangang channel

P1.13

Spatiotemporal evolution of turbidity maximum zone in Minjiang River Estuary, China based on long time series of remote sensing data

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Abstract

Based on GF-1, GF-6 and Landsat series of multi-source remote sensing images, using the suspended sediment concentration distribution data obtained by image reconstruction, the temporal and spatial evolution trend of turbidity maximum zone of Minjiang River Estuary in Fujian Province, China during the flood and dry season from 1989 to 2020 was analyzed. Gabor filtering combined with texture entropy feature extraction method was used to interpret the flow direction and velocity of Chuanshi Channel in Minjiang River Estuary. Combined with chart data and the extracted flow regime data, the influence of large-scale projects such as deep-water channel and sand bar regulation on the temporal and spatial evolution of turbidity maximum zone was further discussed. The results show that in the past 30 years, during the flood season and dry season, turbidity maximum zone of Minjiang River Estuary has moved significantly, and the distribution range has changed. The turbidity zones of Chuanshi Channel and Meihua Channel have gradually separated. Specifically, the concentration of suspended sediment in Chuanshi Channel of Minjiang River Estuary was significantly reduced, and the spread of suspended sediment was wider; the flow direction of Chuanshi Channel was more concentrated, the flow velocity increased, and the effect of runoff in the channel was continuously enhanced. The above results all indicate that the hydrodynamic changes before and after deep-water channel and other large-scale projects will have an important impact on the evolution of turbidity maximum zone in the estuary.

Keywords

Turbidity maximum zone, Flow regime, Remote sensing, Minjiang River Estuary

P1.14

Resilience of temperate seagrass (Zostera noltii) and associated macrofauna to marine heat waves

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Abstract

Seagrasses are marine flowering plants usually found in shallow coastal waters worldwide. The dwarf eelgrass *Zostera noltii* is found in estuarine areas across the north-eastern Atlantic, where it provides key ecosystem services, such as habitat provisioning. A wide variety of benthic macrofauna are attracted to seagrass areas, including epifauna on the leaves of the seagrass and infauna (e.g., polychaete worms, molluscs and crustaceans) in the surface sediments. Benthic macrofauna play an important ecological role as a trophic linkage between primary producers and higher trophic-level predators. The understanding of how such seagrass-associated assemblages' function under marine heat waves (MHWs) is limited. Within this context, we aimed to explore the biological responses of seagrass and associated macrofaunal communities (collected in Sado estuary; 38°28'31" N; 8°46'34"W, Portugal) to simulated short-term (15-day duration) marine heat waves (categories III and IV), including photophysiological parameters, pigments' content, survival rates, and changes in species richness and biodiversity indices. No significant changes on shoot density, electron transport rate (ETR) and maximum PSII quantum yield (Fv/Fm) values, and on most of the pigments analysed were observed among treatments ($p>0.05$). Moreover, Margalef's diversity, Shannon-Wiener and Simpson indexes also did not varied significantly under the different MHWs scenarios. These findings suggest that the *Zostera noltii* meadows show a certain resilience to short-term thermal challenges imposed by MHWs, but further research is needed to fully understand such responses under the chronic long-term scenarios predicted for the ocean of tomorrow.

Keywords

Seagrass, macrofauna, Blue ecosystems, Marine Heat Waves

P1.15

Coastal acid sulfate soil acidification in a heated future: What are the risk factors for estuaries?

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Abstract

Extreme prolonged drought over southern and eastern Australia a decade ago (the Millennium Drought, 1996–2010) triggered extensive coastal acid sulfate soil (CASS) oxidation and associated acidification in the River Murray Estuary (RME), South Australia. Substantial release of metal-enriched acidic drainage was also documented during this event. We use this event as a test case for how climate change and anthropogenic impacts can enhance the vulnerability of estuaries to CASS acidification.

Surficial sediment samples (n=43) and sediment cores (n=5) were collected from the RME's central basin environment and analysed using a suite of geochemical, radiometric dating, and sedimentological methods, to trace the impact of metal-enriched acidic drainage and reconstruct changes in the system's structure and function.

Metals mobilised from oxidised CASS accumulated in the sediments of the RME, with their transport and accumulation controlled by hydrodynamic and geomorphic processes in the estuary. These processes have, however, changed during the history of the RME in response to sea-level and anthropogenic impacts. Significantly, artificially raised water levels and the installation of tidal barrages are identified to have intensified the extremity of the Millennium Drought acidification event.

We demonstrate that many acidification risk factors are extant within the boundary conditions of wave-dominated estuaries, and these systems can be major depositional sinks for acid-mobilised contaminants. The potential disconnection of these estuaries to marine influence, either by tidal barraging or subaerial berm formation greatly exacerbates the likelihood of severe acidification. We also demonstrate that due to complexity in estuarine systems, CASS acidification will often exhibit non-linear behaviour in response to changing boundary conditions, complicating the assessment of risk. Increases in future water extraction and diversion, the construction of tidal barrages, and drier climates, will shift estuarine systems closer to thresholds where severe acidification can be expected.

Keywords

Heavy metals, Acid Sulfate Soils, Climate change, Wave-dominated estuaries

P1.16

FRAGILE vulnerable habitats - Coastal sand dunes and freshwater ponds - in Kolkheti lowland (Georgia) threats and needs for conservation

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Abstract

Fragile vulnerable habitats - Coastal sand dunes and freshwater ponds - in Kolkheti lowland (Georgia) threats and needs for conservation

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Key words: Kolkheti, freshawater, coastal, dune, conservation.

East Black Sea coast line terraces are well developed in the coastal zone of Kolkheti (Colchis) lowland. Whereas, coastal sand dunes and natural freshwater ponds, Sphagnum mires were formed here in the coastal hinterland. Historically, in the coastal area of the Kolkheti, habitats continuesly degraded and disappeared as a result of human activity. This process has significantly increased

from the beginning of the 20th century. Very low public awareness among population importance of ecosystem services providing freshwater ponds and sand dune habitats. Significant anthropogenic factors are water pollution, infrastructure, to build Kulevi Oil terminal and Anaklia Sea ports destroying the dune habitats of the sea coastal line.

Some lagoon-type formations of these freshwater ponds, established behind the sand dunes, still can be found in the area as remnants in-between the Sea and percolation Sphagnum mires. These freshwater pond systems have special importance for biodiversity as they serve as critical habitats for waterfowl. The problem is obviously compounded by the lack of legal framework to protect the habitats. It is advisable to carry *out in-situ & ex-situ* conservation measures.

Keywords

Kolkheti, freshwater, dune, conservation

P1.17

Early 21st century morphodynamics of the NW tip of the Tróia peninsula – 2004 to 2021 (SW coast of Portugal)

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Abstract

Planning of the TROIA RESORT at the turn of the 21st century, on the northernmost area of the 16 km long Tróia peninsula, between the Sado estuary and the Atlantic, integrated known decadal coastal morphodynamics in its design (based on available aerial photographs - 1948 to 1998), by including a *non-edificandi* buffer, whose width varied as a function of local coastal dynamics and the shifting of occupation loads from the most recent dynamic areas to older more stable ones.

Since 2004, large scale topographic surveys have been carried of the tip of the peninsula, where natural coastal progression had locally exceeded 300m. These surveys cover the frontal dune system and the beach berm and face down to the low water mark, along an extension of c.a. 1800 m and were carried out first with a total Leica TCR307 station and since 2012, with an RTK GPS Leica Viva GS/CS15.

Chronological series of digital elevation models over this 18 year period show different patterns: a marked accretion (2006-2007) due to the beach fill operation using sands dredged for construction of the Tróia marina; continued general accretion along the W facing marine coast corresponding to the natural progression of large “sand waves” in a NW alongshore direction (2011-2021) leading to additional progression of the coast line in excess of 200 m, translating into a major gain of available beach area; basculation of the N facing coast with some gain of the local beach area and a corresponding SE retreat of the tip of the peninsula (2008-2021).

Installation and growth of pioneer and primary dune vegetation has allowed for these new areas to be very quickly stabilized and to be resilient e.g. to occasional overtopping, but their loss by erosion is also evident with local dune cuts exceeding 1.5 m in height.

Keywords

coastal morphodynamics, DEM time-series, Tróia (Setúbal, Portugal), frontal dune system

P1.18

Can zooplankton fed allochthonous carbon diets support and sustain juvenile fish?

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Abstract

Freshwater inflows and terrestrial resource inputs have long been linked to fish abundance and catch rates in estuaries but the role of terrestrial carbon in this process is still debated.We performed a study testing the effects of varying levels of terrestrial dissolved organic matter (tDOM) additions to a food limited diet of juvenile Australian bass (*Macquaria novemculeata*). Crustaceous zooplankton *Artemia franciscana* (*Artemia*) were reared for two days under control conditions (no addition) or with additions of tDOM leachate at dissolved organic carbon (DOC) concentrations of 5 mg/L or 10 mg/L. *Artemia* were fed to juvenile bass in their treatment tanks over 42 days at feeding rates reduced by 65-75% of *ad libitum*. Juvenile fish fed the 5 mg/L reared *Artemia* exhibited no statistical difference for weight, standard length, fork length or total length compared to the control treatment. However, fish fed *Artemia* grown in the 10 mg/L tDOM treatment had significant increases ($p < 0.05$) in all length parameters after 28 days compared to other treatments and were significantly greater in weight and dorso-ventral depth by 42 days. Stable isotope analysis of fish tissue did not show significant changes towards signatures of the terrestrial carbon. Decreased highly unsaturated fatty acid (DHA, EPA and ARA) concentrations of fish tissue and weights of juveniles across all treatments suggested utilisation of endogenous lipids and proteins to facilitate growth under food limitation. We suggest that increased terrestrial resource availability in juvenile fish diets subsidised energetic needs, allowing greater proportions of endogenous resources to contribute to growth and development, resulting in greater lengths of fish where tDOM was available. In this manner, organic material of terrestrial origin brought to estuaries by inflows may ecologically link the improved recruitment of juvenile Australian bass and other species to increased freshwater discharge.

Keywords

Allochthnous, Carbon, Fish, Freshwater Inflows

P1.19

Characterizing the carbonate system of the Elbe estuary

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Abstract

Estuaries are net CO_2 sources to the atmosphere, releasing ~0.25 Pg C yr^{-1}, which could counterbalance the shelf uptake of ~0.25 Pg C yr^{-1}. River discharge can influence both, the CO_2 flux from estuary to the atmosphere, as well as the magnitude of dissolved inorganic carbon (DIC) exported to coastal waters. For European countries, climate change is expected to cause an increased precipitation in winter and longer periods of drought in summer. The goal of this study is to elucidate the influence of climate-change-induced hydrological changes on an estuarine carbonate system.

The Elbe River is one of the largest river basins in central Europe, where over 24 million people live in the catchment area. Since 2014, annual Elbe river discharge has been relatively low. 2018 exhibited with 441 $m^3 s^{-1}$ the lowest annual mean river discharge since 1992. The Elbe estuary has been extensively sampled by the Flussgebietsgemeinschaft (FGG) Elbe (*Elbe River Basin Community)*, qualifying the region as a suitable site to study the natural and anthropogenic impacts on estuarine systems. Historical records of carbonate system parameters collected between 1985 and 2018 are being assessed in the present study.

Preliminary results of the 1985-2018 FGG dataset indicate a major shift in the carbonate system dynamics in the Elbe estuary. Between 1985 and 1995, the mean DIC in the estuary decreased by 32% of 754 µmol L^{-1}. After 1995, mean DIC of the estuary increased by 582 µmol L^{-1} up to 2190 µmol L^{-1} by 2018, and displayed a shift in pattern along the estuary. From the freshwater to the mesohaline region, DIC increased from 2100 µmol L^{-1} to 2400 µmol L^{-1}, but decreased to 2200 µmol L^{-1} in the polyhaline zone. Further analysis will focus on the period after 2014, when the estuary had experienced drought conditions.

Keywords

Estuary, Carbonate system, Climate change

P1.21

Attitude: The influential and metaphor elicitation on pollution for river management

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Abstract

This research study attitude and its changes. Zaltman, 1997 acknowledged that attitude change influences the human's mind on pollution without one awareness. That attitude is a set of human's emotions and beliefs that can be changed over time, environment, social roles & norms, classical & operant conditioning, observation and personal experience (Eagly & Chaiken,1995: Fabrigar et al., 2005). This research explores the scholars' theory on attitude change, persuasion, legal/policy influent the people to make behavioural changes. The search to examine the degree of strength and frequency of persuasion required to influence people to alter their attitude and metaphor elicit towards pollution. How much or the degree of attitude changes required to perceive a behavioural change (Maio, 2010). This research demonstrates that pollution persuasive pedagogy can influence one to change their attitude and directly reflect in their behaviour to perceive river pollution. This research aimed to explore what is the influence of attitude towards pollution. This research explores the human perceives the legal institution enforcement and environmental pollution threat and begins to change their attitude and behaviour to suit the situation (McAdams, 2000). He further explained that legal law can physically change community behaviour and possibly moral attitudes, by making the targeted behaviour either more convenient or less convenient. That is to say, the human's attitude and behaviour can be changed to accommodate the environmental situation. The changes in human's attitude and behaviour will impact pollution, especially river and ocean pollution.

Keywords

Attitude, River Management, River and Ocean Pollution, Persuasion

P1.22

Long-term phytoplankton biomass variability in two contrasted french coastal ecosystems in a climate change context

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Abstract

Coastal environments are highly impacted by the combined influence of anthropogenic climate change and the occurrence of persistent episodes of extreme meteorological events: warming of sea waters and changes in nutrient inputs due to the modification of precipitation patterns and consequently on river flows. Here, we study the impact of climate driven changes on phytoplankton biomass dynamics by analyzing high and low frequency of phytoplankton fluorescence and chlorophyll measurements in two French eutrophic ecosystems (Bay of Brest 2000-2019 and Bay of Vilaine 2011-2019). While the frequency and intensity of blooms in the Bay of Vilaine is driven by the supply of nutrients from rivers, no clear relationship is detected in the Bay of Brest where the residence time of water masses is short and the nutrient limitations infrequent. Long-term changes in phytoplankton biomass in these two contrasted ecosystems revealed a strong interannual variability in the timing, intensity and magnitude of blooms that occurred during the growing period (mid-March to mid-September). We observed that the first spring bloom is initiated in 2019 about 30 days earlier than 20 years ago in the Bay of Brest while it is delayed by 20 days in a decade in the Bay of Vilaine. These modifications in the timing of the phytoplankton bloom are related to a “shift” in sea surface temperature and changes in solar irradiance, as originating from the influence of large-scale hydro-climatological processes.

Keywords

Sea surface temperature evolution, Coastal eutrophic ecosystems, Extreme events, Climate Change

P1.23

Erodibility of vertically exposed salt marsh sediments

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Abstract

Change in the extent of valuable salt marsh habitat is occurring globally, and includes widespread losses in Northwest Europe. These lateral losses are occurring despite relative stability in vertical elevation in relation to sea level. While there are increasing efforts to quantify salt marsh loss and an improved understanding of the mechanisms by which salt marshes can change in the lateral dimension, empirical field evidence exploring the role of specific marsh properties remains lacking.

This study investigated the role of bulk sediment characteristics and substrate structures, such as lamination and root material, in controlling the internal stability of vertical marsh sections when exposed to tidal flat conditions.

Intertidal sediment cores were extracted from two contrasting UK salt marsh sites: clay-silt rich Tillingham Marsh, Essex, Southeast England and sand-dominated Warton Marsh, Morecambe Bay, Northwest England. During a field experiment over the 2018-2019 winter, vertical sections from cores extracted from both locations were exposed to *in-situ* external forcing conditions on the tidal flat at Tillingham Marsh. Volumetric and structural changes to the exposed vertical faces of the cores were quantified using structure-from-motion digital photogrammetry, conducted at approximately 14-day intervals. These three-dimensional models were analysed alongside empirical water level measurements and meteorological data.

The clay-rich sediments were more resistant to erosion, with the greatest loss of material occurring typically around root structures in the sand-dominated marsh sediments. This indicates possible variability in the mechanical role of rooting structures (as suggested by Feagin et al. 2009; Ford et al. 2016) under different marsh sedimentology. Small-scale (cm) lateral marsh stability is thus influenced by interactions between physical sediment, biological structures and hydrodynamic sequencing. Understanding under which conditions, including location and wave regime, these factors become more or less important will be crucial towards modelling and predicting future salt marsh change.

Keywords

Erosion, Morphodynamics

P1.24

Seagrass blades effect on the sediment capture under oscillatory flow

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Abstract

Seagrass meadows are known to enhance particle sedimentation inside the canopy. However, the seagrass impact on the vertical distribution of sediment coming from external sources, which reaches the meadow, is still unclear. This study aims to determine the amount of particles retained by a seagrass meadow. Based on the hydrodynamics four meadow compartments can be separated: the blades, the seabed, within the canopy layer and above the canopy layer. A set of laboratory experiments were conducted under different hydrodynamic real field conditions. This study demonstrates and quantifies that seagrass meadows decrease the volume of suspended sediment by two mechanisms: capturing the suspended sediment by the seagrass blades and promoting the particle sedimentation to the seabed. This study also demonstrates that the amount of sediment particles trapped by single seagrass blades decreases with canopy density. However, when considering the trapping by the total number of blades, the sediment captured by all the blades of the meadow increases with canopy density. Moreover, this study demonstrates that there is a decrease in the suspended particles within the canopy compared with the bare seabed, which implied an improvement in the water clarity. Furthermore, compared with the bare seabed, increasing the canopy density the particle sedimentation increases, making evident the contribution of the vegetation in enhancing sedimentation.

Keywords

Seagrass, Sediment capture, turbulent kinetic energy, oscillatory flow

P1.25

Integrated Institutional of Land-Sea Eco-environmental Protection and Restoration Based on MSES in the GBA

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Abstract

There is a wide range of natural, social and economic links between land and sea. It is a complex adaptive system coupled with a typical social system and ecological system. It has the characteristics of integrity, interaction, indivisibility, complexity and uncertainty, which determines that the Protection and Restoration of Land-Sea Ecological and Environment（PRLSEE） needs to be systematic and complexity method. Fortunately, the theory of marine social-ecological system（MSES） provides an effective solution to this need. MSES emphasizes the integration of land-sea social system and ecological system to realize the integrated management of eco-environment protection and restoration, and to design institutional that matches the diversity of natural ecological and economic and social conditions to resolve all kinds of problems. And defuse all kinds of risks with different characteristics (Ostrom, 2005). So， this paper takes the PRLSEE in the Great Bay Area of China as an example under different institutional environments, combines with the framework of MSES cooperative governance, and uses the method of institutional equilibrium analysis to focus on the institutional needs of the PRLSEE in the Great Bay Area. The results show that the PRLSEE in the Great Bay Area has the same origin and homology. The integrated protection and restoration meets the requirements of ecosystem integrity, and is also conducive to the interaction and healthy development of land-sea social system and ecological system. Therefore, according to the goal of integrated land-sea social-ecological governance, this paper proposes to design an integrated system for the PRLSEE in the Great Bay Area, including institutional environmental arrangements, institutional coordination mechanisms and specific institutional structures, such as the ecological red line institutional, ecological environment supervision institutional， ecological environment governance institutional, pollution emission permit institutional, ecological damage and environmental pollution punishment institutional, ecological environment damage compensation institutional, etc.

Keywords

Land sea interaction, Ecological protection , MSES

P2.01

The estuaries of Fingal, Ireland: local and national governance meets science

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Abstract

The three estuaries of the Fingal municipal region of north-east county Dublin are distinctive consisting of dispersed, multiple, freshwater feeds from small post-glacial streams and rivers, with large sand-spits at the mouth of each estuary. All three are nature reserves, designated under habitats directive, they hold abundant water-fowl/waders and fall under the 'control' of the Irish National Parks and Wildlife Service (NPWS). Other stakeholders to sections are Fingal County Council who own adjoining parks, golf-clubs with adjoining links courses, fisherman, yachting clubs, farmers, and Birdwatch Ireland (the Irish equivalent of RSPB). Management of the estuaries is by benign-neglect with a generally hands-off approach to local interests which on the whole works as designation has halted plans to develop the estuaries for industrial-scale amenity and closing the land-fill in one estuary. Protected species are protected by informing landowners of responsibilities of non-disturbance, but protected species often require more active management of the habitats such as water-course management, invasive species remediation, water source protection, cleaning, and educational/outreach activities in order to bring on side local communities. The MARINE project (Marine & Aquatic Research Innovating New Education) is a multidisciplinary approach to managing an estuary involving a monitoring/surveying aspect of all species and of aquatic pollutants coupled with an educational aspect involving estuarine shore clean-ups, teaching workshops, and data/information provided to local groups via community lists, local newsletters and working with local schools and groups. This paper outlines progress to date.

Keywords

Estuaries, Local communities, Local government

P2.02

The effects of artificial light on nocturnal foraging rates of estuary overwintering waders

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Abstract

Availability of light, whether natural or artificial, is known to alter the nocturnal behaviour of wading birds, influencing site-selection, predator avoidance, and foraging. In the case of foraging, the absence of light can significantly reduce the efficacy of visual foragers, impacting their foraging rates and energetic intake. Artificial light is increasingly prevalent in urbanising and industrialising estuaries and theoretically enables nocturnally foraging waders to become less reliant on tactile methods, optimising their foraging behaviour. However, relatively little is known about the nocturnal foraging behaviour of waders and it has rarely been quantified, with even less known about the impact of artificial light. This poster aims to quantify and contrast nocturnal and diurnal foraging rates of a widespread wader species, the common redshank (*Tringa totanus*), between dark and artificially lit estuarine mudflats.

Video recordings of the behaviour of >15 individuals were made at multiple sites around the Humber Estuary during two consecutive winters using a camcorder and night vision equipment. The rate of steps, pecks, and probes were extracted from this footage and compared statistically. Preliminary findings suggest differences between the foraging rates of individuals at dark and artificially lit sites. This project will provide important data to inform future conservation strategies and contribute to the sustainable management, and development, of estuarine landscapes.

Keywords

Artificial light, Foraging behaviour, Wading birds, Nocturnal ecology

P2.03

Effects of anthropogenic geomorphological changes on hypoxia in Tokyo Bay

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Abstract

At Tokyo Bay, over 90% of the natural tidal flats have been taken up by reclamation; consequently, approximately 100 million m^3 of borrow pit (BP) has been left on the seafloor. These anthropogenic geomorphological changes have been indicated as some of the major causes of hypoxia and anoxia. In this study, numerical simulations were conducted to quantitatively analyze the effects of BPs, navigation channels (NCs), and reclamation on hypoxia.

Three simulations were conducted with the same boundary conditions and settings but different bathymetry data: Case 1 is with the bathymetry of the present Tokyo Bay; in Case 2, the grids of the major BPs and NCs at the bay head are modified to the adjacent water depth (i.e., filled); Case 3 is with the bathymetry of the 1800s, the Meiji Era (Fig. 1).

The model was validated by comparing to hourly observations; consistent results of the bottom dissolved oxygen (DO) were obtained in Case 1 (Fig. 2). In summer, the mean concentration of DO in bottom water is 2.59, 2.61, and 3.46 mg/L in Case 1, 2, and 3, respectively. Although filling the BPs and NCs did not change the volume of hypoxic water significantly, it decreased 10.5% of the volume of anoxic water. Density stratification in the Meiji Era was 16.6% weaker than that in the present; consequently, the vertical transport of oxygen through the 5 m interface was enhanced by 57.3%.

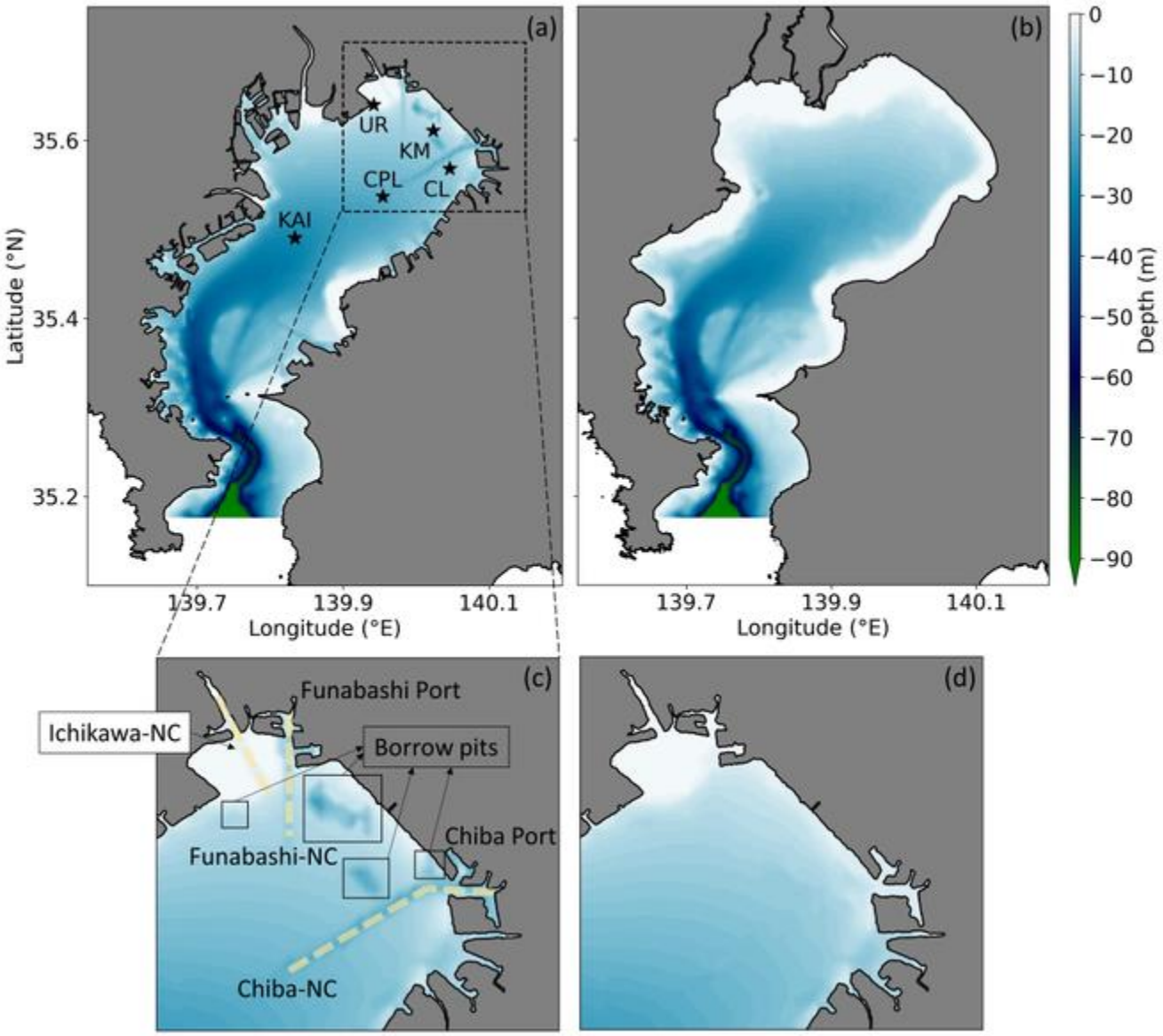

Fig. 1. Bathymetry of Tokyo Bay at present (a) and in the Meiji Era (b), the major BPs and NCs at the bay head which is filled in Case 2 (c), and the bathymetry after the filling (d).

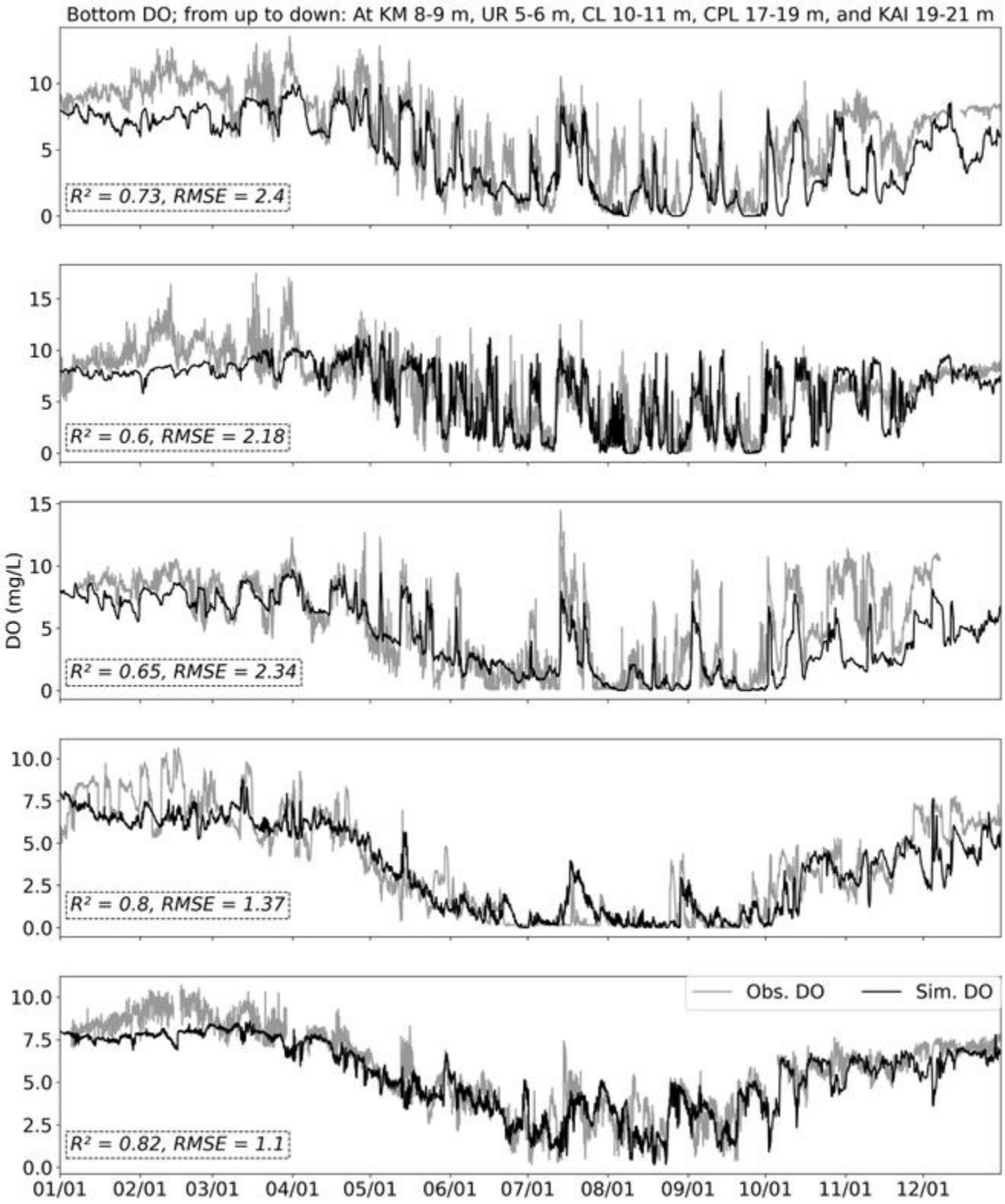

Fig. 2. Observed and simulated dissolved oxygen at the bottom of KM, UR, CL, CPL, and KAI; see Fig. 1a for the location of the observatories.

Keywords

Coastal hypoxia, Anthoropogenic geomorphological change, Tokyo Bay, Numerical simulation

P2.04

Niche shifts in zooplankton taxa after the introduction of new copepod species in two Basque estuaries

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Abstract

The effect of the non-indigenous species (NIS) *Acartia tonsa, Pseudodiaptomus marinus* and *Oithona davisae*, and two other expanding species (OES) (*Acartia bifilosa* and *Calanipeda aquaedulcis*) on the realized ecological niche of zooplankton taxa in the estuaries of Bilbao and Urdaibai (south-eastern Bay of Biscay) was analysed from data obtained from 1998 to 2015 along the salinity gradient of each estuary. Within Outlying Mean Index (WitOMI) calculations were performed to explore niche shifts in zooplankton taxa after the sequential settlement of NIS and OES since 2003 and 2010, respectively. Temporal changes in the niche overlap of NIS with the native copepod species were also analysed by using the Schoener's D-metric. Results showed that NIS and OES colonized principally the empty habitats devoid of brackish dominant species of the inner estuary of Bilbao, while NIS settlement was limited by biotic (congeneric brackish indigenous species) and hydrodynamic (water circulation and mixing) constraints in the estuary of Urdaibai. In the estuary of Bilbao, the realized niche of some neritic taxa, including that of congeneric species, showed temporal shifts related to the occupation of the estuary by NIS and OES. In the estuary of Urdaibai, no noticeable shifts directly linked to NIS were observed probably as a result of the less successful colonization of this estuary by NIS. The niche overlap between the NIS and the other copepod species increased along the study period likely due to the effect of the time of coexistence.

Keywords

non-indigenous species, niche, estuaries, plankton

P2.05

Sources of variability in functional diversity and uniqueness of the benthic ecosystem

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Abstract

Describing how communities change over time is crucial to better understand and predict ecosystem functioning. In this context, the purpose of this study was firstly to investigate changes in functional diversity and functional redundancy of soft-bottom macrofaunal communities after a quarter of a century, and secondly to determine the main mechanisms structuring these communities (i.e., deterministic *versus* stochastic processes). To achieve this, a large data set was used which included species abundance data collected in 1989 and 2014 from several sampling sites along a transect line (70-160m depth) in Heraklion bay, Crete (south Aegean Sea). A biological trait analysis (BTA) was conducted on the macrofaunal communities to determine their functional role. Functional diversity indices, including functional richness, evenness, as well as uniqueness, i.e., the functional contribution of single species to the overall redundancy of the whole assemblage, were calculated. Significant differences were recorded between the two sampling years. In order to determine the mechanisms that drove these differences, the species co-occurrence networks (based on species abundances) were compared to the functional networks (based on species traits) for the two periods, following a methodological approach based on the network theory and modularity concept. The result of this comparison showed that in 1989, the distribution of species within both networks was not different from a random pattern of distribution, indicating either that stochastic processes were the main factors structuring the community or that there was not a clear dominance of deterministic processes - environmental filtering or competition. In contrast, in 2014, the two networks were similar, indicating that environmental conditions have acted as a major filter on species distribution.

Keywords

macrofauna, functional diversity, species co-occurence, uniqueness

P2.06

Comparative analysis of cryptic incrusting biota of autonomous reef monitoring structures (ARMS) from tupinambás ecological station, são paulo state, brazil

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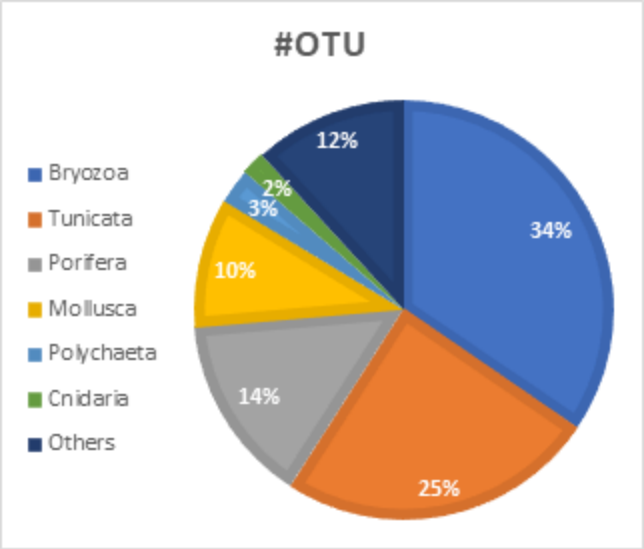
Abstract

Reef ecosystems are amongst the most complex, valuable, and diverse marine ecosystems. Part of the benthic fauna that inhabits these areas is called cryptic fauna, usually composed by small sized invertebrates. These hidden communities live in crevices or inside the reef matrix and their study is hampered by the limited access to this component and troublesome taxonomic identification. To deal with this fraction of the reef biodiversity, the ARMS (Autonomous Reef Monitoring Structures) were conceived. Given how quickly reef systems are losing their resilience, the goal of this work is to analyze and compare the cryptic incrusting biota found inside ARMS from two main locations, Alcatrazes and Ubatuba, inside the Tupinambás Ecological Station on the northern coast of the São Paulo state, Brazil. ARMS were deployed in March 2019 and, one year later, retrieved for processing. Photographs in high resolution were taken during processing and images of 216 plate faces were then analyzed in the CoralNet platform. Identifications were made to the lowest taxonomic resolution and considered operational taxonomic units (OTU). A total of 110 OTUs belonging to fauna, algae and other components were identified, all considered in the analyses. Bryozoans, tunicates, and sponges were the most abundant organisms (figure 1). Red algae were also abundant, especially on the edges of the plates. Sites from Alcatrazes showed higher species richness, while Ubatuba had higher diversity. Assessments on beta diversity revealed that species turnover was more relevant than nestedness amongst all spatial scales analyzed, even considering microhabitats inside the ARMS. This is the first set of ARMS properly analyzed in the Southern Atlantic, and data from metabarcoding are being generated for future comparisons with other localities. These results highlight the convenience of ARMS as a tool for monitoring hard bottom communities in marine protected areas in Brazil.



Keywords

Cryptic biota, ARMS, Ecology, Incrusting biota

P2.07

Trend dynamics in physical and chemical water parameters in the Venice Lagoon (Italy)

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Abstract

The Venice Lagoon is the largest wetland in the Mediterranean.

Since 2011, ISPRA and ARPAV have assessed the ecological status of Water Bodies (WBs) of the Venice Lagoon, within the Water Framework Directive (WFD), which includes monitoring of physical and chemical parameters in water. Veneto Region has funded monitoring activities. The present work aimed at describing the trend dynamics of these parameters.

Water parameters were seasonally collected in thirteen WBs (30 stations in total) of the Venice Lagoon from 2011 to 2019.

Seasonal Kendall test was applied to data of temperature, pH, dissolved oxygen, total suspended solid (TSS), carbon, nitrogen and phosphorous compounds, silicates, chlorophyll-*a*. Fluctuations in pH were observed, whilst temperature displayed positive trends, although not significant, as reported for longer-term dynamics in the central part of the lagoon. Reductions in oxygen conditions were observed in the central WBs of the lagoon, often affected by hypoxia and/or anoxia phenomena in the last years, and where, on the contrary, chlorophyll-*a* significantly increased. TSS reduced only in a WB in the northern lagoon. A general reduction in nutrient concentrations was observed, mostly due to orthophosphates rather than nitrogen compounds (total dissolved nitrogen, dissolved inorganic nitrogen, nitrates), being the first significantly decreasing in six WBs and the latter only in one or two WBs, depending on parameter. Total and dissolved organic carbons significantly decreased only in one WB, placed in the inner part of the lagoon, whilst particulate organic carbon significantly decreased in two WBs more influenced by the sea.

The present study is a baseline for future investigations, as describing trend analysis of data from the whole Venice Lagoon. For some parameters, results could be also useful to support Water Managers in the assessment of the ecological status (WFD *sensu*) and adoption and/or review of the effectiveness of measures.

Keywords

Seasonal Kendall Test, Transitional waters, Water Framework Directive, Nutrients

P2.08

Seasonal variability of inorganic nutrients and their molar ratios in the Gulf of Cadiz

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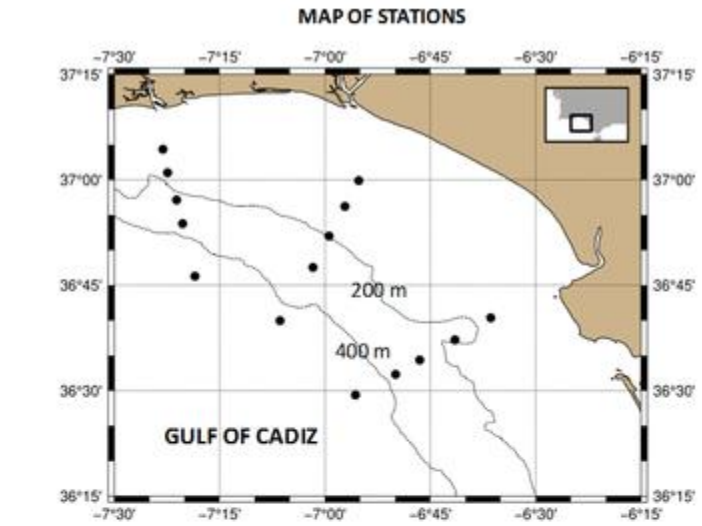
Abstract

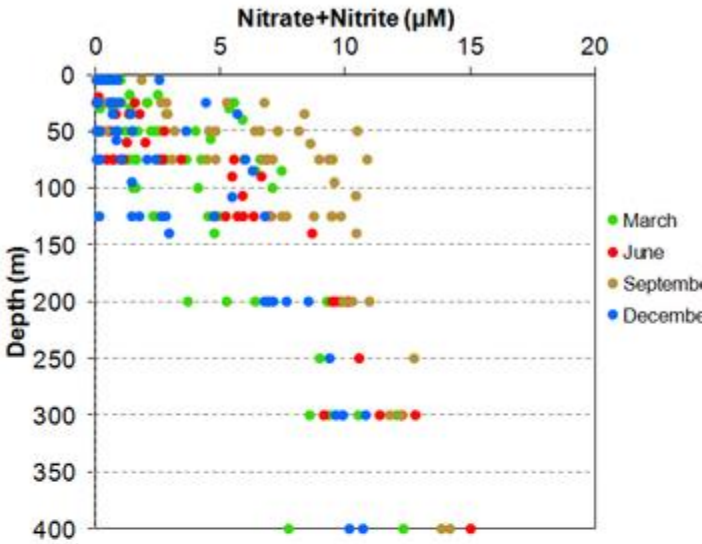
This work analyses the seasonal variability of inorganic nutrients (nitrate+nitrite, phosphate and silicate) and the N:P and N:Si molar ratios in the Gulf of Cadiz.

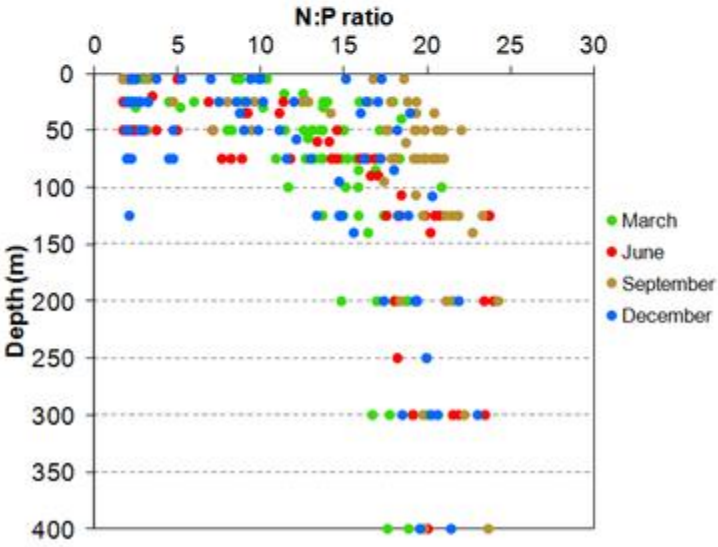
Samples were collected in 2017 (March, June, September and December) in the framework of the IEO project STOCA, and nutrients analysed by segmented flow.

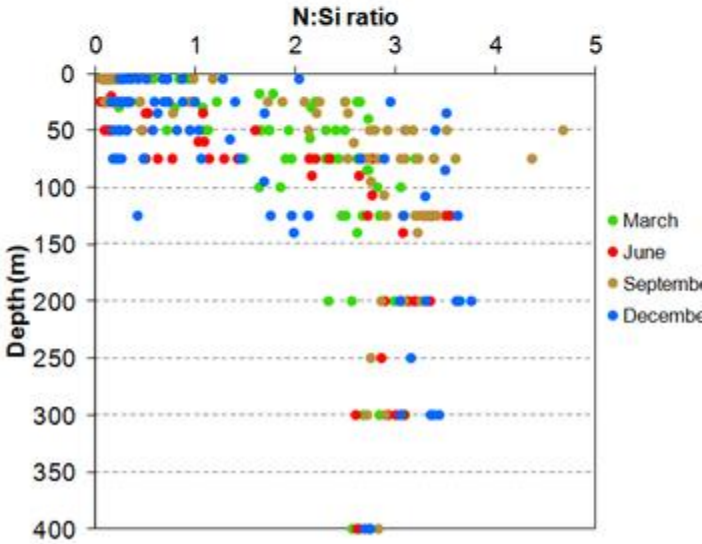
Nutrient concentrations were low in the surface layer, particularly in June when nitrate and phosphate were depleted at most of the stations. Below these layers nutrients increased quickly with depth in September compared to the other cruises, so that between ~25-250 m the highest concentrations were found in September. At greater depths higher concentrations were detected in both June and September. The higher concentrations of nutrients were associated to a greater influence of North Atlantic Central Water (NACW). The N:P ratio, where N represents nitrate+nitrite, was in general <16:1 in the upper 25 m at most of the stations, nevertheless in September values close to 20 were observed at some stations. The N:P ratio increased notably with depth, with higher values between 25-75 m in September. Between 200-400 m the lower N:P ratios were observed in March (<20:1), while higher values (around 20:1) were usually found in the other seasons. In general the N:Si ratio was < 1:1 in the upper 25m, with the lower values in June. The ratio increased sharply with depth up to values >3:1 at ~50-250 m depth, depending on the cruise. Between 200-300 m the highest values were observed in December.

The results show that the variability of NACW had a marked impact on the seasonal dynamics of nutrients and their molar ratios in the water column, with the higher nutrient values in the upper 250 m in September associated to the upwelling of NACW.









Keywords

Nutrients, NACW, Gulf of Cadiz, Seasonal variability

P2.09

A holistic framework for identifying human well-being indicators for marine ecosystem services in China

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Abstract

The concept of human well-being and its relation to ecosystem services has been defined by the Millennium Ecosystem Assessment (MEA). The ecosystem services approach is based on the inter dependencies between nature and human well-being. However, while the ecosystem services aspect of this approach is well-developed, the human well-being aspect remains unstructured and vaguely defined. A national measure of well-being is needed which is responsive to changes in the provisioning of ecosystem services. To conceptualize the linkages of ecosystem and human, we must identify the measurable components of well-being that can be related to marine ecosystem service. Based on the indicators and metrics used in existing well-being indices, this paper describes a framework that identifies eight domains of human well-being and discusses the potential relationships between marine ecosystem services and the domains selected. And then the social attributes and indicators are developed to the Chinese context. This research will serve as the foundation for developing an index of well-being which will be used to evaluate the provisioning of marine ecosystem services in a predictive modeling framework.

P2.10

Promote a sustainable fishery in a mediterranean lagoon through the recruitment of undersized target species

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Abstract

This study reports the experimental trials undertaken to minimize the discharge of undersized target species caught by the small-scale fishery in Lesina lagoon (S. Italy). Our aim was to assess the amount of bycatch and, more specifically, to collect discharged juveniles of European eels, *Anguilla anguilla* (Linnaeus, 1758), and grey mullets, *Mugilidae spp.* (Jarocki, 1822) for future restocking in nature. A total of 22 fishing surveys involving 236 fyke-nets were performed between October 2019 and February 2020. Undersized individuals of eels and mullets were kept alive on-board using small plastic tanks filled with aerated lagoon water. After biometric data were recorded, animals were released in a semi-closed aquaculture facility (ponds). During the study period, the bycatch rate by weight was 62.5 % with undersized grey mullets being the second most abundant taxa (8.2 % kg.). The discharge rate of mullets was 98.2 % by number and 81.2 % by weight from the total mullets catch, while the discharge rate of eels was 71.1 % by number and 11.2 % by weight from the total eels catch. A total of 211 juvenile eels and 206 juvenile mullets were selected from the bycatch portion and kept inside the semi-closed ponds facility for 153 and 122 days, respectively. At the end of the study the overall survivals (53.1% eels and 49.5% mullets), were collected from the ponds and released in nature. In the context of Blue Growth and the Code of Conduct for Responsible Fisheries, our results highlight a suitable strategy that minimizes fishing impact, promoting sustainable management of local natural resources. The use of simple methodologies that enhance the survival of undersize target species, together with their maintenance in aquaculture facilities for short periods, would contribute to improve population restocking actions

Keywords

lagoon bycatch, artisanal fishery, aquaculture facilities, population restocking

P2.11

A Restoration sector for sustainable blue growth and marine habitat recovery

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[1]Hellenic Centre for Marine Research, Greece. [2]University of Côte d'Azur, France. [3]Università Politecnica delle Marche, Italy. [4]Deep Seas Environmental Solutions Ltd., UK

Abstract

Deterioration of marine ecosystems destroys their biodiversity and functioning, thus degrading many habitats of keystone organisms and causing the collapse of the natural capital. Habitat loss has been observed in tropical coastal systems and is an increasing concern for the European Seas. Increased awareness of 1) the issues arising from the degradation of nature such as loss of provisioning and recreational services and 2) the renewed societal appreciation of blue and green spaces for our lives, raises the ambition level for marine ecosystem conservation and management.

Gradual change in societal appreciation of the coasts and oceans and the ecosystem services they provide coupled with shock events causing mass mortalities, and the recent COVID pandemic, strengthen the restoration narrative. This is reflected in the UN Decade of Restoration Ecology and the policy drive in the EU in the Green Deal and a new Biodiversity Strategy in line with the motto 'Biodiversity is essential for life. Our planet and the economy depend on it. When nature is healthy, it protects and provides'.

Traditional conservation approaches in the marine environment include 1) limiting impacting human activities and 2) securing appropriate and adequate spaces for networks of protected areas for habitat recovery. However, beyond conflicts for space from human activities causing impacts, there are new business opportunities for innovation in support of restoration and ocean health.

Societal and policy demands for change in business models towards sustainability, circularity, biodiversity, offsetting initiatives and corporate social responsibility, support the creation of a new sector actively supporting marine ecosystem restoration with innovative products and solutions. Examples of solutions developed by private, government and science partnerships around restoration cases will be presented based on the AFRIMED and MERCES projects' focused Business Clubs, showing the emergence of a multifaceted Restoration sector with new companies occupying the 'Blue space'.

Keywords

restoration, blue growth, recovery, business

P2.13

Development of the Closed-Circulation Plant at Onshore for aquaculture of bivalves and verification of the release timing

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Abstract

Short-necked clams （Thereafter, it will be referred to as clams） are well known as a fishery resource and fulfill an important role in the substance cycle of the sea. It is also an important organism for learning about the environment, for example, by tidal clamming. However, the catch of Japanese clams is decreasing every year, the causes are decrease of tidal flats which are the habitat of clams, increase of seawater temperature at a tidal flat, large-scale flood in summer, and disturbance of habitat by typhoons.

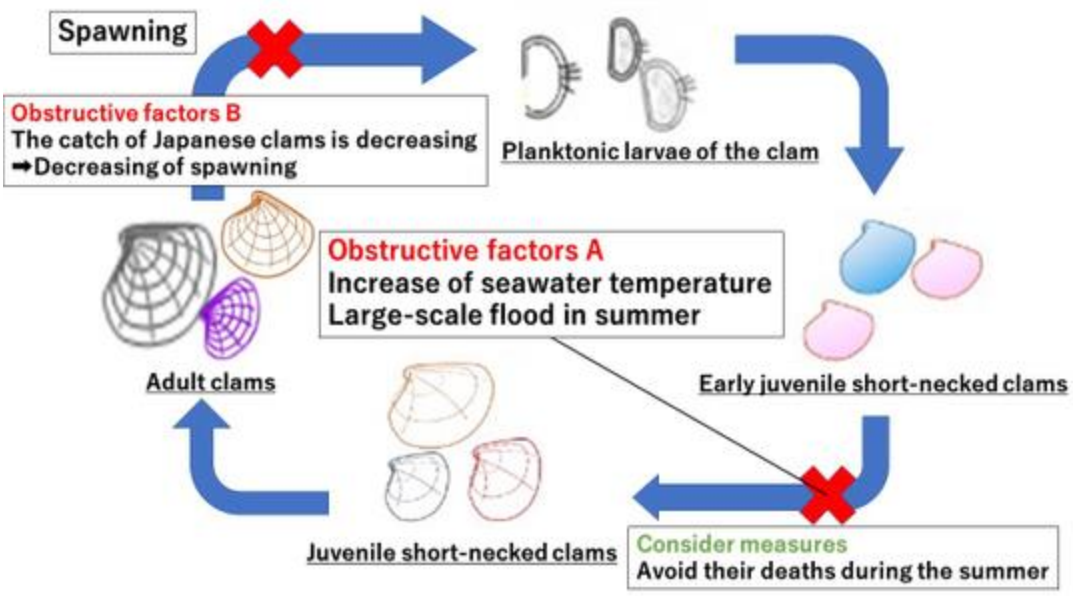

Fig.1. Factors in the decline of clams resources

In this study, The Closed-Circulation Plant at Onshore （Thereafter, it will be referred to as CCPO.） was used to cultivate clams in order to avoid their deaths during the summer. In addition, experiment of releasing clams into a tidal flat was conducted to verify the timing of the release for their, and the optimum release timing was determined from the survival rate and growth increment of the clams.

Fig.2. The Closed-Circulation Plant at Onshore for cultivate clams

Fig.3. Experiment of releasing clams

Results of the experiment of CCPO showed a survival rate of 63.5% per year and an average shell length growth of 0.137 mm per month, suggesting the need to tune the feeding speed and frequency for clam survival and growth.

Result of the experiment of releasing clams in June to September was survived 32% to 49% per month. In result of October was survived 77% per month, confirmed the most viable value during the release timing. Average shell length grew 1.1 to 3.4 mm per month in each month, 2.0 mm per month in October.

Keywords

closed-circulation plant, aquaculture of bivalves, resource of clams, tidal flat

P2.14

Keeping sharks at bay: shark deterrents and their applications

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Abstract

With both humans and sharks representing key players in today's ocean, finding strategies to alleviate the effects of negative interactions is an increasingly pressing endeavor. Sharks occupy essential functional roles in marine ecosystems, as high-ranking predators, whilst representing one of the most threatened groups of vertebrates. With populations drastically declining due to overfishing and other anthropogenic pressures, it is urgent to both curb their exploitation and reduce the negative consequences of human-shark interactions. Sharks possess an impressive array of highly specialized sensory systems that may be used to selectively manipulate their behavior and develop strategies aimed at reducing interactions. Over the past 70 years, several studies have been conducted to find an effective personal shark deterrent to prevent shark attacks on human. More recently, with the increased need for shark conservation, the research focus shifted towards the development of sensory-based repellent devices to reduce bycatch. Here we assess the effectiveness and potential for application of different sensory-based [(i) electroreception, (ii) vision, (iii) olfaction, (iv) audition, (v) multisensory] deterrents. Research illustrates inter and intraspecific variation and even individuality in behavioral responses of sharks to stimuli, which seem to be, in part, related with a variety of biotic and abiotic factors, which may diminish or maximize repellent effectiveness. The applications for each type of repellent are discussed while having in mind cost and practicality, as various social, economic, logistical, and ecological challenges need to be considered in the search for eco-friendly, feasible and effective shark deterrents.

Keywords

Sharks, Bycatch, Deterrents, Human-shark interactions

P2.15

Changes in macrozoobenthos community after aquatic plant restoration in the northern Venice Lagoon (Italy)

Federica Oselladore[1], Federica Cacciatore[1], Valentina Bernarello[1], Michele Cornello[1], Rossella Boscolo Brusà[1], Adriano Sfriso[2], Andrea Bonometto[1]

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Abstract

The response of macrozoobenthic community to an ecological restoration activity in the northern Venice Lagoon was studied from 2014 to 2017, within the scope of the project LIFE12NAT/IT/000331 – SEagrass RESTOration (SeResto) www.lifeseresto.eu. The project aimed at recreating aquatic phanerogam meadows (*Zostera marina*, *Zostera noltei, Ruppia cirrhosa*) in this area, where they were largely reduced in the last years, because of several anthropogenic pressures. The project ended in 2018; transplants were successfully at almost all project areas.

Macrozoobenthos was sampled in eight stations before (2014) and after (2015, 2016, 2017) transplanting activities. In 2017, samples were collected both on bare sediments, and on those planted, in order to highlight differences and benefits from aquatic plant restoration. Benthic invertebrate assemblages were investigated using univariate ecological measures (abundance, richness, Shannon's, Margalef's, Pielou's indices), multivariate analysis (Hierarchical Cluster Analysis, MDS, ANOSIM, SIMPER) and the multivariate ecological index, M-AMBI.

Results showed an increasing in abundances and fluctuations in richness and univariate ecological indices during years. Comparing unvegetated and vegetated samples in 2017, every index but Pielou's increased in the latter.

Multivariate analysis grouped samples for localization rather than years, with differences between stations due to abundances of common species, such as *Gammarus insensibilis*, *Bittium reticulatum*, *Cerastoderma glaucum, Nepthys hombergii*. In the last sampling year, results were grouped by the presence or the absence of aquatic plants with differences in abundances of grazer and filter-feeding species (*G. insensibilis*, *Gibbula adriatica*, *B. reticulatum*, *Caprella* sp.).

M-AMBI results depicted general conditions from moderate to good ecological status (*sensu* Water Framework Directive) with similar fluctuations as presented by univariate indices from 2014 to 2017. Responses of macrozoobenthic community were clearer when comparing vegetated and unvegetated samples, being the first rather better than the latter and demonstrating the supporting function of aquatic plants to benthic communities.

Keywords

Benthos, Transitional waters, Ecological indicators, Seagrass transplantation

P2.16

Stress-resistant corals as breeding stock for coral restoration projects in the Western Gulf of Thailand

Thamasak Yeemin, Makamas Sutthacheep, Sitiporn Pengsakun, Wanlaya Klinthong, Charernmee Chamchoy, Wiphawan Aunkhongthong, Laongdow Jungrak, Arirush Wongnutpranont, Ploypailin Rangseethampanya

Ramkhamhaeng University, Thailand

Abstract

Elevated seawater temperatures have caused widespread coral bleaching at most coral reefs worldwide. Shallow reef flat communities in the estuaries are in extreme environments, especially high temperature, light intensity and sedimentation. However, some scleractinian corals are resistant to environmental stresses and coral bleaching events. This study investigated the scleractinian coral community on a shallow reef flat in the estuarine environment at Ko Maphrao, Mu Ko Chumphon National Park, the Western Gulf of Thailand. The field surveys were conducted on the shallow reef flat, about 1 m in depth, during high tides by using a belt transect method. The live coral cover was about 45%. The dominant corals were *Porites lutea*, *Dipsastraea favus*, *Favites abdita*, *Turbinaria mesenterina*, *Pavona decussata* and *Goniopora columna*. Most coral colonies were over 75 centimeters in diameter. This study highlights the importance of shallow reef flats in the estuarine environment of the Western Gulf of Thailand as high potential reef sites for parent coral colonies contributing to breeding stock for coral restoration of the impacted reefs following the bleaching events.

Keywords

breeding stock , coral bleaching, estuarine, Gulf of Thailand

P2.17

Diversity and vertical distribution of Micromolluscs in the Gulf of Mannar marine biosphere reserve, Tamil nadu, India

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Abstract

The diversity and vertical distribution of micromolluscs were examined in the core sediments of Kurusadai and Shingle Islands, Gulf of Mannar, India. A total of 66 subsamples were sectioned at a depth interval of 6 cm from the 5 core sediment samples which were collected from the coral islands. The depth of the core ranged from 72 to 90 cm. In all the samples, 57 micromollusc species (i.e. 49 gastropods and 8 bivalves) were identified. Shannon-Wiener diversity index and Pielou's evenness index of gastropods and bivalves ranged from 0.574 to 2.472 and 0.693 to 1.782; 0.829 to 1.0 and 0.978 to 1.0 respectively. Shannon diversity index of micromolluscs decreased with depth. Among the 5 cores, the highest species richness (3.357) was observed in Kurusadai A core and the least species richness was found in Shingle Island. The abundant gastropod species were *Rissoina pachystoma, Melanella sp., Clithon oualaniense* and *Cyclostrema sp.* whereas, the abundant bivalves were *Timoclea* and *Anadara sp.* The Principal Component Analysis of the variables showed that 28.89% of the total variance was accounted by positive factor loadings of silt, clay, protein, sulphate carbohydrate, and the remaining parameters like sand, organic carbon, and organic matter were negatively loaded. The bivariate Pearson correlation matrix of the studied parameters such as clay vs silt, silt vs carbohydrate, clay vs protein showed significant positive factor loading ($p < 0.001$). Redundancy analysis showed that the percentage of sand was the highest determining factor in the composition of gastropods and bivalves in the sampling stations.

Keywords

coral islands, core sediments, micromolluscs, diversity indices

P2.18

Rare earth elements in sharks

Joana Raimundo[1], Pedro Brito[1], Vanessa M. Lopes[2], Catarina Santos[2], Guilherme Bismarck[2], Miguel Caetano[1], Rui Rosa[2]

[1]IPMA - Portuguese Institute of Sea and Atmosphere, Portugal. [2]MARE - Faculdade de Ciências da Universidade de Lisboa, Portugal

Abstract

Nowadays rare earth elements (REEs) are of critical importance in several areas of activity,

including modern electronic technology, medicine, industry and agriculture. With the ongoing increasing demand, the transfer to aquatic ecosystems will significantly increase in the near future in different forms, for example, wastewater and industrial emissions, surface run-off and atmospheric deposition. Consequently, REEs are now considered as emergent contaminants, and an increased understanding of their biogeochemical behavior and ecotoxicology is of paramount importance. Sharks play a key role in the structure of marine food webs as top and mesopredators, and are facing major threats due to overfishing and habitat degradation. This study aimed to provide the first characterization of REEs (namely 14 different elements - La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu) in two tissues (muscle and liver) of 10 different sharks species from coastal, open ocean and deep-sea habitats. REEs values showed significant interspecific differences, but they were consistently higher in the muscle than in the liver. Also, the levels of light REEs (LREE: La, Ce, Pr, Nd, Sm e Eu) were always higher than the heavy ones (HREEs: Gd, Tb, Dy, Ho, Er, Tm, Yb e Lu). These results are in agreement with the natural abundance observed in the environment. The potential relationships between LREE, HREEs and shark life strategies and habitats will be discussed. Last, it is worth mentioning that the present findings are the baseline for future comparisons.

Keywords

Sharks, Rare earth elements , Contamination, Pollution

P2.19

Understanding microplastic routes from the source to the ocean by exploring their transport by the Mondego river, Portugal

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[1]NOVA University, Portugal. [2]University of Coimbra, Portugal

Abstract

The exponential growth of plastic production associated with inefficient waste management is changing the marine ecosystem and has the potential to impact life on Earth. Breakdown of plastic and direct inputs of pellets, shavings and microbeads result in microplastics (MP) dispersion in the environment, and rivers are the main routes for MP transport to the ocean. Depending on their density, they have the capacity to remain suspended in the water surface and water column, while the effects of weathering and biofouling can transport them to the seabed and be ingested by pelagic and benthic organisms, being transferred along the food web. Effective strategies must be implemented to flatten the pollution curve.

Samples of water and sediments were collected along the Mondego river and estuary in strategic points according to possible inputs from plastic producers, recyclers and WWTP, in different seasons to understand the distribution of different MP. Different types of MP were found, displaying distinctive colours, shapes, sizes, and chemical composition. The abundances and the type of MP vary throughout the year and according to the selected sampling locations, and data so far suggest that transport of MP from the river to the sea occurs mostly in winter, as expected.

Field data will be integrated in a transport model for the river, coupled with a coastal drift model to predict transport and target hot spots from the Mondego river to the estuary and the sea. With this knowledge, strategies are being studied and implemented in collaboration with the stakeholders who have an awareness and willingness to change, boosting the collaborative and effective strategies to mitigate this environmental problem, enabling industries to improve their safety and sustainability in our Blue Society.

Keywords

Microplastic routes, River Sea, Mitigation strategies, Sustainability

P2.20

Impact of dredging on the fitness of the dwarf eelgrass (Zostera noltii) meadows: the case of Sado Estuary

Marco Franzitta[1], Tiago Repolho[1], Catarina Frazão Santos[1], José R. Paula[1], Isabel Caçador[1], Ana Rita Matos[2], Bernardo Duarte[1], Rui Rosa[1]

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Abstract

Sado estuary is the second largest estuary in Portugal and an area classified as a natural reserve given its high biodiversity. *Zostera noltii* meadows are abundant all over the estuary and are extremely important to maintain the estuarine ecosystem functional, providing important ecological and economic services. The decline observed along the years in seagrass meadows cover were mainly attributable to human activities, like the presence of industrial area in the northern margin of the estuary (organic and chemical waste disposal) and harbour activities (navigation, dredging). Recently (between December 2019 and end of 2020), a consistent dredging operation took place removing 3.2 million cubic meters of sand to deepen the access channel of the Port of Setubal. We collected sediment and seagrass samples before and after the beginning of dredging activities in four selected areas of the estuary, following a gradient of anthropogenic disturbance. Biochemical (leaf pigments, antioxidant enzymes and fatty acids) and elemental analysis of both leaves and sediments were assessed. Preliminary results showed that the seagrass sites in the industrial area on the northern margin of the estuary were the most impacted ones, revealing a significant reduction in Chlorophyll (a and b) and carotenoids (b-carotene, Zeaxanthine) content, an increase in Catalase and Glutathione Reductase activity, and a change in the Metal Pollution Index (MPI).Multivariate analyses clearly also showed significant spatial differences, but the temporal patterns (dredging-related) were less clear through the gradient of anthropogenic disturbance. Our findings show that the recent dredging impacted the fitness of seagrass meadows, may be due to disposal of the dredged material, increased turbidity and the resuspension of contaminants already stabilized in the sediments.

Keywords

Dredging, Seagrass meadows, Zostera noltii, Sado Estuary

P2.21

Response of feacal indicators to effluents dispersal of three wastewater treatment plants in ria formosa lagoon – south Portugal

Sandra M. Caetano, Alexandra Cravo, Ana B. Barbosa, Cátia Correia, André Matos, Maria J. Lima, José Jacob, Carla Freitas

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Abstract

Ria Formosa (RF) is a highly productive coastal lagoon located in south of Portugal and the most important national bivalve producer. RF receives treated effluents from several Wastewater Treatment Plants (WWTP). Depending on effluent loads, location of discharge points and hydrodynamics, these could impact bivalves, (deeply reliant on water quality) human health, and socio-economic activities. Thus, studies of microbial indicators of faecal contamination are crucial in systems such as RF under the influence of effluents dispersal. This study compares the dispersion of *Escherichia coli* (EC) and Enterococci (E) at three areas in RF near bivalve production areas, influenced by WWTP, monthly (low tide) from September 2018 to September 2020. These areas are representative of different effluent discharge and hydrodynamics of the receiving waters: site 1- low flow (2000 m^3/day), at a main channel, deep and wide in connection with a main inlet with high water renewal; site 2 – intermediate flow (4000 m^3/day), at an intermediate channel in direction to a main channel; site 3 - high flow (16000 m^3/day), at a shallow and narrow channel, with restricted circulation. Considering both bacteriological indicators, lower contamination was detected at site 1 and higher at site 3, reflecting higher effluent discharge and weaker hydrodynamics at the later. This pattern was also supported by other chemical key water quality determinants A higher ratio of concentration of EC to E was also observed at site 3. For each area, faecal indicators decreased gradually with the distance from the discharge point. No consistent intra-annual variability pattern was detected. These results allow a better understanding of the impact of different WWTP on RF water quality, crucial for future wastewater management, which ultimately contribute to protect the valuable bivalve resources. Moreover, this knowledge could be extended to other similar systems worldwide.

Keywords

Faecal indicators , Waste Water Treatment Plant, Water quality, Coastal Lagoons

P2.22

Effects of flame retardants (BDE47) exposure on benthic organisms from coastal area: experiment on symbiont-bearing foraminifera of the genus *Peneroplis*

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Abstract

Benthic foraminifera are unicellular marine organisms widely present in world oceans and seas, representing an important knot of the food network and seabed ecosystem. Due to their sensitivity to environmental changes and pollution, they are often used as bioindicators, providing an efficient tool in toxicity studies on different pollutant affection. Among benthic foraminifera, the family Peneroplide is constituted by specimens with average to large dimensions, living in temperate and low-deep coastal waters and bearing symbiont algae. Foraminifera response to environmental stress (eg. pollutants) includes morphological and physiological alterations and the loss of vitality, the reproduction arrest and the expulsion of symbiont algae from the cell (when present). Among the pollutants affecting marine coastal and estuarine environments persistent flame retardants (Polybrominated diphenyl ethers - PBDEs) are often found. It was assessed that also low-level exposures of BDE-47, a PBDEs congener, can affect marine organisms development. In order to assess the effect of BDE-47 exposures on benthic organisms from costal marine environment, foraminifera specimens belonging to Peneroplidae family were sampled and exposed to non-lethal BDE47 concentrations from T0 up to 48h, and vitality indicators were analysed during the experiment. Changes in the pseudopodial activity and length, movement, reduction of ectoplasm dimension, and the loss of symbiont algae were measured in presence of BDE47. The results show the sensitivity of this species to BDE-47 exposure, suggesting the nocive repercussion of PBDEs pollution on marine coastal ecosystems, in relation to the organisms in it selves and to the effect of biomagnification on the food-web and human health.

Keywords

vitality indicators, coastal large foraminifera, bleaching, PBDEs toxicity

P2.23

Beach configuration and distance from the ocean determine the small-scale distribution of macroplastics in the intertidal zone of central Spitsbergen, Arctic.

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Abstract

In this study, we estimated the variety and distribution of macroplastics in the central part of Spitsbergen, Svalbard archipelago, European Arctic. In July 2019, we surveyed nine coastal sites within Isfjorden and Forlandsundet. The littoral transect lengths varied from 160 to 2100 m, totaling 10810 m. All marine litter items were photographed and georeferenced and then identified using the OSPAR (2010) classification guide. The majority (90%) of marine debris was from macroplastics, accounting for 45% of all categories listed in the OSPAR guidelines. The average number of macroplastic objects found in the study area was 1.9 ± 0.4 per 100 m, which is in the range of similar numbers found in the remote polar regions of the Arctic and Antarctic. Using the geolocation data, it was determined that the full diversity of macroplastic items in the study area can be found after studying approx. 7-8 kilometers of coastline, i.e., lengthening the research route does not lead to the finding of new macroplastic categories. Correlation analysis showed that the amount of macroplastic debris found within the sections is inversely proportional to the distance from the transect to the open ocean, and also directly proportional to the to wave fetch distance within the study site. On a small scale (about 100 m), beach configuration and substrate type were important factors in determining the distribution of macroplastic: the average number of items per 100 m was 2,9 ± 0,7 on sandy beaches vs 0,9 ± 0,2 on rocky beaches, and 3,3 ± 1,0 in small embayments vs 1,8 ± 0,5 at straight shores and 0,8 ± 0,3 at the capes. Cluster analysis based on the similarity of macroplastic categories and their density revealed three clear groups of locations: 1) the closest to the open ocean (with the greatest variety and density of items), 2) at a medium distance, 3) most remote (least variety and density).

Keywords

Svalbard, marine litter , OSPAR classification, factors affecting distribution

P2.24

Organic matter biogeochemical characterization of surface sediments in the São Francisco canal mouth from Sepetiba bay, Rio de Janeiro

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Abstract

This study aims were to characterize the organic matter (OM) biogeochemistry of the São Francisco Canal mouth by analyzing grain-size (fine-grained), elemental (C_{org} and N_{total}) and isotopic ($\delta^{13}C$ e $\delta^{15}N$) composition in eighteen superficial sediments (0-5cm).[a1] The grain-size, elemental and isotopic composition were determined by using the Melvern Mastersizer (Low Angle Laser Light Scattering) and the Flash 2000 (Organic Elemental Analyzer – Thermo Scientific) coupled to a mass spectrometer Delta V Advantage (Isotope Ratio Mass Spectrometer, IRMS – Thermo Scientific).[a2] Fine-grained content, C_{org} and N_{total} concentration, $\delta^{13}C$ and $\delta^{15}N$ composition and the C/N ratio values varied from 20.29 to 96.60%, 0.46 to 2.07%, 0.05 to 0.22 % -24.4 to -21.9‰, 2.31 to 6.2‰ and 9.07 to 15.92 respectively.[a3] After normalization and a similarity (ANOSIM) test, variations between fined-grained, elemental concentration and isotopic composition were evaluated through nonmetric multidimensional scaling (nMDS). The nMDS (Stress: 0.121; Euclidean distance) showed two distinct ordinations between the stations close (St1-St6 and St9) and distant (St10-St18) to the São Francisco channel mouth, due to the general increasing trend in the fine-grained and C_{org} contration. These results reflect the efficient dispersion of the materials launched by the channel in the bay. The C/N ratio and $\delta^{13}C$ values indicated a mixture of OM sources but $\delta^{15}N$ values showed a predominant terrestrial contribution in most stations. However, the two-end-member model presented a marine average (53 ± 13%) relatively higher than terrestrial contribution (43 ± 13 %). This result could be related to the supply of nitrogen compounds from untreated sewage, through the São Francisco Channel, which increases the growth rates of phytoplankton. Therefore, it is possible to observe two differences between the stations close and distant to the São Francisco Channel related to the local hydrodynamic. Even if a mixture of OM was observed the biggest contribution came from marine sources.

Keywords

STABLE ISOTOPES, CARBON , NITROGEN

P2.25

Metals mobility assessment in sediments of São Francisco canal mouth from Sepetiba bay, Rio de Janeiro

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Abstract

The Sepetiba Bay (Brazil Southeast) is a known metal contamination site, mainly for Cd and Zn, due to the erosion of rejection pile left after a metal industry deactivation in the 90s. This bay has also important harbors, demanding periodic dredging and reflecting directly in the mobility of the metals. The main goal of this work was the assessment of metal mobility associated with grain-size.[a1] To achieve that goal 18 superficial sediment samples at São Francisco Canal mouth were collected for metals and grain size analyses with the Van-Veen support, pH and Eh were measured for each sample with a Hanna Multiparameter Probe. The metal mobility assessment was analyzed for exchangeable, reducible, oxidizable, and residual fractions through the sequential extraction procedure that was proposed by the European Community Bureau of Reference (BCR). For grain-size analyses, the samples were sieved in 1mm mesh and analyzed in Melvern Mastersizer (Low Angle Laser Light Scattering).[a2] The results demonstrate Cd and Zn are mainly associated with exchangeable (Cd and Zn medium 0,46 g kg^{-1} and 149,40 g kg^{-1} respectively) and reducible fractions (Cd and Zn medium 0,27 g kg^{-1} and 65,55 g kg^{-1} respectively), while Fe, Cr, Cu, Ni, and Al is associated with residual fraction.[a3] Those metals associated with residual fraction are probably related to the mineral assembly on sediment, and should not represent a considerable environmental risk of the biota. The metals associated with exchangeable and reducible fraction are related with strongly reducing characteristics on surface sediments, consequently to reduced hydrodynamics and high organic matter input. However, Cd and Zn could represent a risk, mainly in resuspension sediment events, alterations on pH, and Eh promoted by oxygenation of sediment due to suspension could be capable of collaborating to release these metals from the water column.[a4]

Keywords

SEQUENTIAL EXTRACTION, TRACE ELEMENTS, RIO DE JANEIRO, BCR-701

P2.26

Towards the restration of the rich and beautiful Seto Inland sea - Hyogo strategies-

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Abstract

The Seto Inland Sea is one of Japan's major enclosed coastal seas and was once known for its scenic beauty and rich aquatic resources. However, as the coastal areas were urbanized and industrialized during the rapid economic development period, the sea suffered water quality deterioration and rapid eutrophication from industrial and domestic discharges. As a result, the sea became what is called a "dying sea."
Measures, such as regulating the source of industrial discharge and developing domestic water treatment facilities, were taken to help improve the water quality of the Seto Inland Sea. Although the water quality did improve significantly, the fish catch continues to decline in recent years due to lack of nutrition. It is essential to retain nutrients, such as nitrogen and phosphorus, for phytoplankton that support the bottom of the food chain to maintain a rich ecosystem.
In order to properly manage the sea's nutrient level, the Hyogo Prefectural Government became the nation's first prefecture to set the water quality target value of nutrients concentration level in marine waters (minimum values: Nitrogen 0.2mg/L, Phosphorus 0.02mg/L) by amending the Act on Conservation and Creation of the Environment in October 2019.

Further efforts will be made to recover the fish catch, elevate the seaweed quality, and sustain the rich ecosystem while controlling the water quality and creating a habitat for aquatic animals to restore the rich and beautiful Seto Inland Sea.

Keywords

Seto Inland Sea, nutrient control, minimum value

P2.27

Preserving high priority tidal wetlands from future sea-level rise by engineering past tidal regimes

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Abstract

Climate change-driven Sea Level Rise (SLR) is creating a major global environmental crisis in coastal ecosystems, however, limited practical solutions are provided to prevent or mitigate the impacts. Here, we propose a novel eco-engineering solution to protect highly valued vegetated intertidal ecosystems. The new 'Tidal Replicate Method' involves the creation of a synthetic tidal regime that mimics the desired hydroperiod for intertidal wetlands. This synthetic tidal regime can then be applied via automated tidal control systems, "SmartGates", at suitable locations. As a proof of concept study, this method was applied at an intertidal wetland with the aim of restabilising saltmarsh vegetation at a location representative of SLR. Results from aerial drone surveys and on-ground vegetation sampling indicated that the Tidal Replicate Method effectively established saltmarsh onsite over a three-year period of post-restoration, showing the method is able to protect endangered intertidal ecosystems from submersion. If applied globally, this method can protect high value coastal wetlands with similar environmental settings, including over 1,184,000 ha of Ramsar coastal wetlands. This equates to a saving of US$230 billion in ecosystem services per year. This solution can play an important role in the global effort to conserve coastal wetlands under accelerating SLR.

Keywords

Mangroves, Saltmarsh, Tidal Restoration, Ramsar Wetlands

P2.28

Vulnerability to sea-level rise and the potential for restoration to enhance blue carbon sequestration in salt marshes of an urban estuary.

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Abstract

Coastal wetlands can be vulnerable to sea-level rise (SLR) but are valued as nature-based solutions to climate change mitigation and adaptation. Ecosystem services and benefits derived from these habitats can be degraded by anthropogenic impacts, so restoration activities are promoted as a management approach. This study examined the potential for hydrological restoration of disused commercial salt extraction pans to enhance carbon (C) sequestration in the urban Swartkops Estuary, South Africa. We also considered the impact of SLR to 2100 on the distribution of estuarine habitats, the vulnerability of built infrastructure to tidal flooding, and how C sequestration is projected to change over time using the Sea-Level Affecting Marshes Model (SLAMM). Restoration of 320 ha to estuarine habitat was estimated to generate an increase of 67 850 Mg C. Establishing tidal connectivity was investigated as a potential restoration action, but most of the salt pan area was above the elevation of the current tidal range and would require excavation. Conversion of the salt pans to estuarine habitat was predicted to occur without intervention under SLR, but 44% of the original area would remain unchanged. Restoration of these areas would significantly increase the extent of transitional/floodplain marsh, even under SLR to 2100. C sequestration was predicted to be 15% higher (54 614.8 Mg C) by 2100 if the salt pans could be restored, compared to if no action is taken. Overall, restoration has the potential to enhance C sequestration, but SLR will still cause large losses of supratidal marsh due to 'coastal squeeze' and extensive tidal flooding of developed areas by 2100 in the lower reaches of the estuary. A full-scale restoration approach for the Swartkops Estuary could use C sequestration potential and carbon offsetting, but additional social and ecological goals need to be incorporated for a holistic and beneficial outcome.

Keywords

Sea-Level Affecting Marshes Model, tidal marsh, carbon storage, Spartina maritima

P2.29

Un-muddying the waters: assessing intertidal mudflats conditions in Irish Sea marine protected areas to inform management strategies.

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Abstract

Intertidal mudflats and saltmarshes are highly productive coastal habitats, serving as a transition zone between terrestrial and marine ecosystems and providing a wealth of ecosystem services, including providing nursery and feeding grounds for many species of conservation and commercial importance, such as plaice, cod, and sea bass. These habitats are important for overwintering and wading birds, which depend on them for food, nesting, and migration. Their importance was formally recognised in 1971 following the Ramsar Convention on Wetlands of International Importance, yet their conservation status remains largely uncertain, particularly for mudflats, as they are difficult to survey, and a complete understanding of their complex biophysical processes has yet to be established. While intertidal mudflats and saltmarshes are found all around the UK coastline, there are few routine field surveys of intertidal mudflats, making effective conservation of these habitats in the face of rising anthropogenic and climate pressures challenging. Marine protected areas (MPAs) across the UK list *mudflats and sandflats not covered by seawater at low tide* as a designation feature separate from saltmarshes, but they are often managed together – where management exists. A lack of resources has resulted in a number of paper parks around the UK, where MPAs are designated but not adequately managed. This study will use remote sensing through satellite imagery (i.e., Landsat and Sentinel-2) and population data of key species (such as shorebirds) to explore the changes in mudflat – and, to an extent, saltmarsh – conditions on a spatiotemporal scale in two Irish Sea MPAs. It will also assess strategies for management in achieving or maintaining favourable conditions for these habitats.

Keywords

marine protected area, mudflat, intertidal, remote sensing

P2.30

Time-series detection of sediment discharge within highly turbid coastal waters in Borneo region with MODIS ocean colour products

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Abstract

Among various water quality pollutants, sediment discharge into our river and coastal systems is a persistent global and regional concern, yet it poses major challenges in minimizing its environmental impacts without continuous study and monitoring over space and time. Here, we present our developed total suspended solids (TSS) empirical remote sensing model in studying and detecting sediment discharge from Sarawak, Borneo coastal region which leads to South China Sea, with study area of 2x2 spatial grid size. With MODIS products, we studied how sediment discharge is influenced by monsoonal periods (dry and wet season) and how it changes over nearly 20 years. Our results showed that wet season during Northeast (NE) monsoon (December – February) generally estimated doubling amount of sediment discharge into coastal waters as compared to dry season, with a total coastal area of 5-8% recorded 10-30mg/L of TSS, while less than 1% ranged from 30-70mg/L. Moreover, although 70-100mg/L of TSS estimation was also recorded and constituted less than 1% of the total area, it represented nearly 1000m of coastal waters area with exceptionally high sediment concentrations. Our study also found that sediment discharge and distribution may not generally displayed similar trend during yearly monsoon season, when more than 10% of coastal waters was recorded with nearly 30mg/L of sediment concentration, while less than 3% was recorded, in year 2008 and 2016 respectively during NE period. While these findings need to be further investigated with rainfall datasets, our initial results reveal the variability of how sediments discharge can impact our coastal waters over time and fundamentally provides insights and understandings on ways to further manage, control and mitigate the release of sediments into our waters for the sustainable use of our coastal waters and its resources.

Keywords

remote sensing, South China Sea, monsoon, TSS

P2.31

Accounting for the light attenuation caused by particulate inorganic material in a coastal ecosystem using remote sensing products and in-situ measurements

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Abstract

Primary production (PP) by phytoplankton is a key process for marine ecosystem functioning. It is dependent on the availability of nutrients and light. Representation of the light climate in coastal systems, especially regarding the particulate inorganic material (PIM), is still a major problem. Particularly for assessing the eutrophication status of a coastal system, misrepresentation of light climate may cause misleading estimates of PP, e.g., by ecosystem models. A number of models exist that directly calculate PIM concentrations, but coupling these with ecosystem models leads to computational overheads.

In this study, we aim to derive a monthly climatology of PIM concentrations based on observation data within the southern North Sea (SNS), which can then be used as a forcing field in an ecosystem model. We combine 20 years' worth of data from GlobColour and IFREMER to compute climatological monthly means in the SNS (Fig. 1). Quality of the satellite products within the nearshore, partially inter-tidal regions of this system is questionable (Fig. 2), which we therefore seek to improve using in-situ data. We analyze the structure of error in relation to environmental variables, like season of year, salinity, grain size, sediment type and bottom depth (e.g., Fig. 3). Based on these relationships, we derive a unifying correction function and apply this within the entire domain, and thereby achieve an improved representation of PIM within the SNS. Finally, we test the use and relevance of this approach by using the resulting PIM estimates as forcing in an ecosystem model, and show that the spatio-temporal patterns in estimated nutrient and light limitation, and consequently the PP is significantly altered relative to a reference model where the turbidity due to PIM is assumed to be constant over time and space, representing the implicit assumption commonly made in ecosystem models.

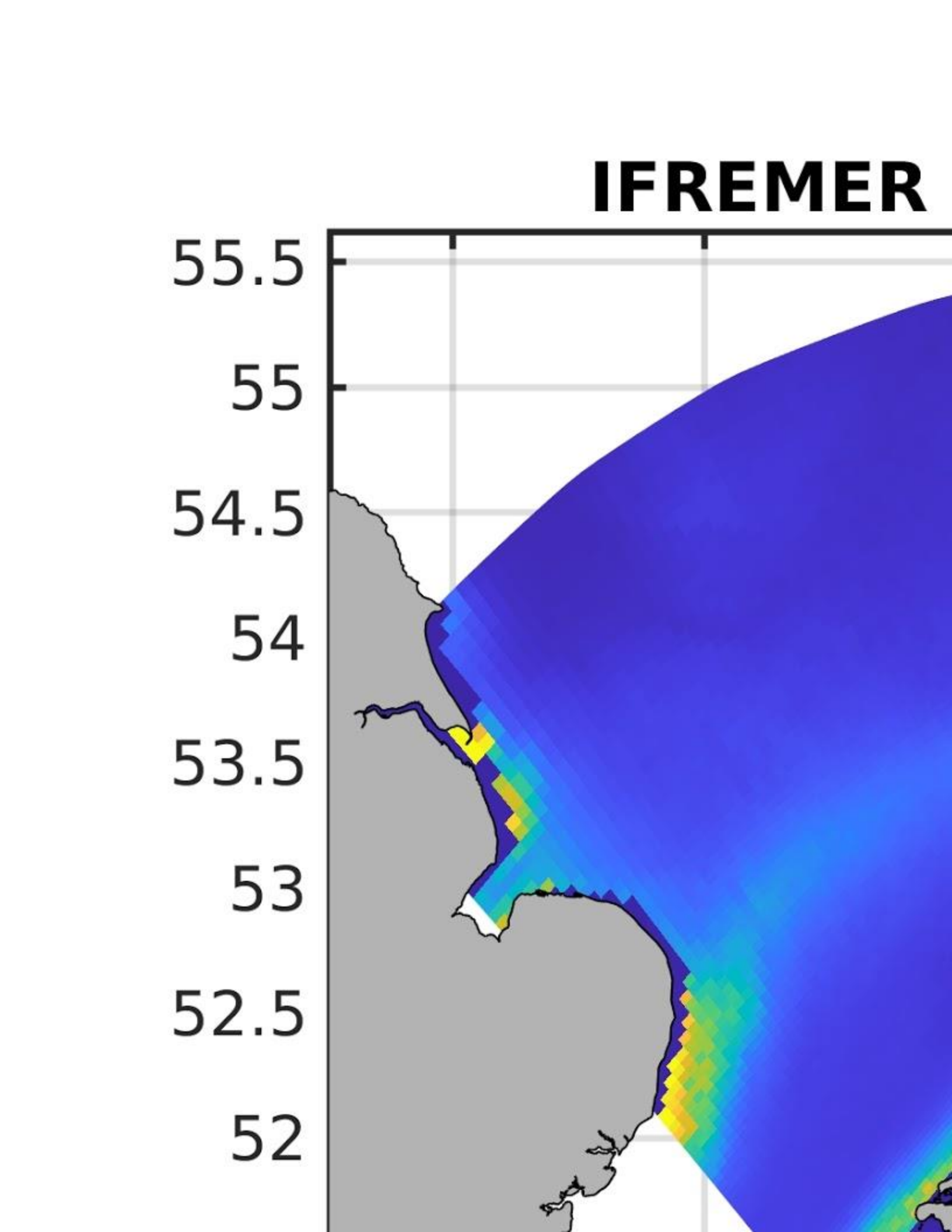
IFREMER
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Fig. 1: long-term average of IFREMER data,
interpolated onto the model grid

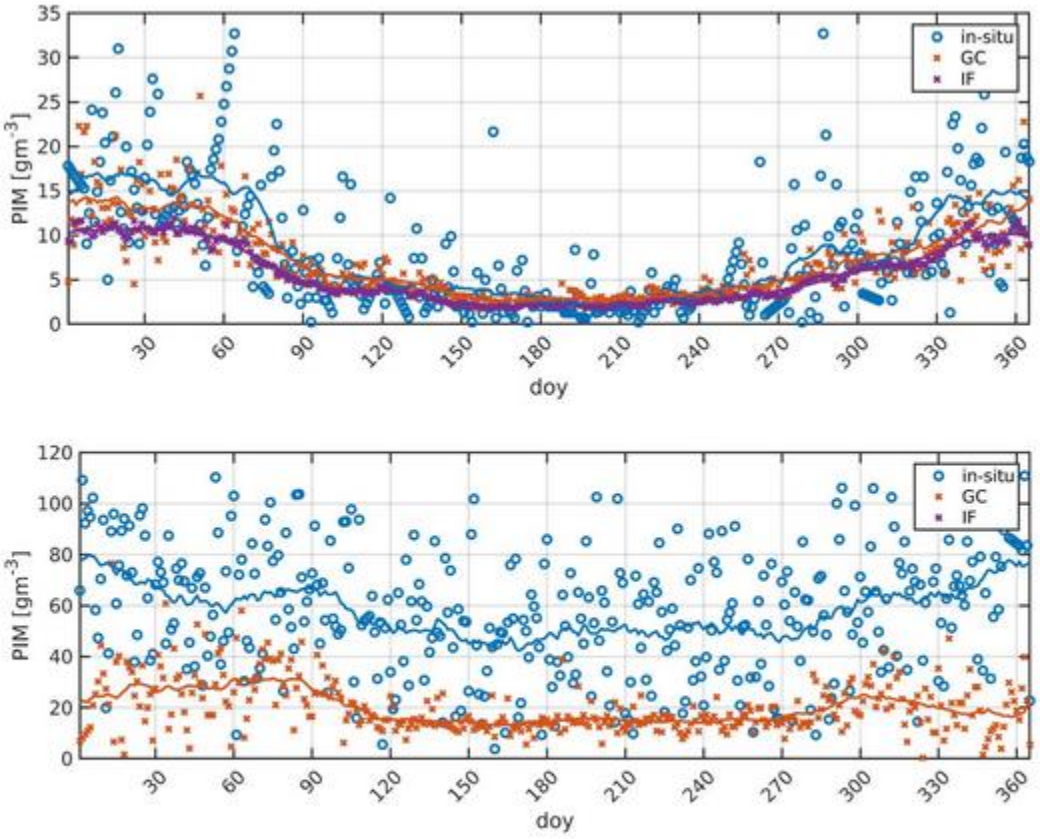

Fig. 2: daily climatology, linearly interpolated, for >20 years at an offshore (top, 23m depth) and a nearshore station (bottom, 8m depth). Blue: in-situ, red: GlobColour, purple: IFREMER

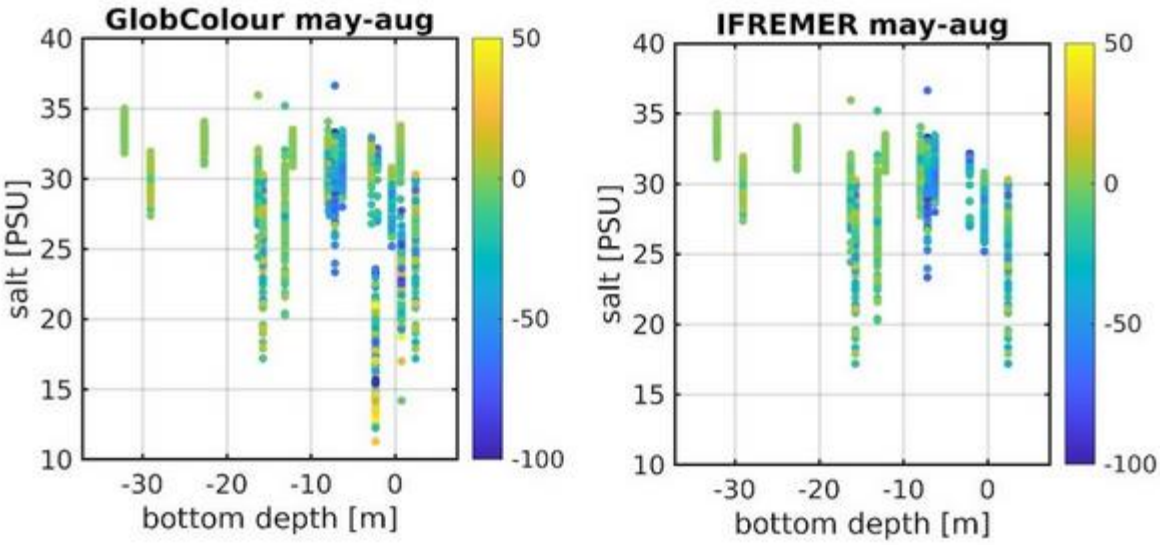

Fig 3: Difference between satellite and station data (color) as a function of bottom depth and salinity.

Keywords

light, ecosystem model, SPM, PIM

P3.01

Effect of change of each meteorological element on the circulation in Lake Biwa, Japan

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Abstract

The currents of circulation flow play an important role in the transportation and mixing of dissolved or suspended nutrients and chemical substances. The significant feature of the flow field in Lake Biwa, Japan is the system of the circulation formed in the surface layer of the northern part of the lake. In recent years, the climate changes such as the change of air temperature, wind speed and precipitation have affected the flow field in Lake Biwa. However, how much the change of each meteorological element can influence the flow field is not clarified enough yet. Therefore, it is essential to evaluate the effects of each meteorological element on the flow field qualitatively. In the present study, we investigated the effect of the change in air temperature, wind speed and precipitation on the change of flow field in Lake Biwa by using a three-dimensional hydrodynamic model. Numerical simulations were carried out for a baseline case using realistic meteorological data from 2007 to 2012 and hypothetical cases using meteorological data with modified air temperature, wind speed and precipitation for sensitivity analysis. The analysis showed that the increase and decrease in air temperature changed the stratification in the surface layer slightly. It caused the strength of circulation in the surface layer to be different from the one compared with the condition of change of the wind speed. Moreover, the increase and decrease in precipitation hardly changed the strength of the circulation. The increase and decrease in wind speed, however, altered the wind stress acting on the surface of the lake, so that it significantly influenced the strength of circulation. The increase in wind speed made the radius of the circulation in Lake Biwa longer and the decrease in wind speed made it shorter both above and below the thermocline.

Keywords

climate change, circulation, flow field, lake

P3.02

An analytical solution of the salinity variation with tidal waves in well-mixed estuaries

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Abstract

Salinity variation in estuaries largely depends on the interaction between river flow and tidal current. However, the variability in river and tidal inputs to estuaries have been disrupted due to climate change and anthropogenic activities. Thus the salt intrusion becomes a serious problem in estuaries in recent years, which has some negative impact on the estuarine eco-environment as well as the water resource potential. Many research efforts have been conducted with different approaches to address this issue worldwide. An analytical model of salinity variation offers a simple and efficient method to study salt intrusion in estuaries. But in the most of theoretical models, the salt intrusion is predicted as a steady-state solution during slack water. Here, an unsteady analytical solution is presented to analyse the intratidal salinity intrusion dynamics in well-mixed estuaries. It is derived from a one-dimensional advection-diffusion equation for salinity with an assumption of multi-frequency tidal waves. The deduced analytical solution is illustrated with applications to the Pearl River Delta (PRD) in China as well to the Kapuas River Delta (KRD) in Indonesia. The unsteady state analytical model has been quantitatively evaluated by using the field data and demonstrated to be an efficient approach to describe the temporal variation of salt intrusion in a well-mixed estuary. The influences of the tide and river discharge are adequately reflected in the analytical expression.

Keywords

intratidal variation, tidal species, salinity, well-mixed estuary

P3.03

FindFish knowledge transfer platform – results from the hydrodynamic component of the ecofish numerical model

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Abstract

The FindFish Knowledge Transfer Platform project was launched to provide solutions for challenges facing commercial fisheries. Its purpose is to provide fishers with a knowledge transfer platform and a numerical forecasting system for the marine environment of the Gulf of Gdansk. By combining in-situ research, environmental data, fish catch data, and numerical calculations, this tool will improve the accuracy of targeted fishing while reducing by-catch. The system will provide more reliable data on fish stocks and facilitate more efficient resource management. The FindFish project addresses problems that were identified as contributing to the declining profitability of commercial fisheries and increased fishing times and emissions of pollutants into the environment. Numerical modeling will allow fishers to make the most economical use of available catch limits. An added value of the project will be to improve maritime safety and working conditions. Catching the same quantity of fish during shorter fishing trips will relieve vessel crews and improve safety. Fuel consumption will also decrease, leading to further savings and less environmental pollution.

In this presentation we discuss the initial implementation of the EcoFish model (hydrodynamic component) and present the results of the model simulations compared to observations from monitoring stations and satellite images. Verification indicate its suitability for forecasting hydrodynamic conditions within the concerned region. Satisfactory compatibility between in situ measurements and simulations enables reliable physical conditions to be established for future simulations with the active biogeochemical part and Fish module.

Financial support for this study was provided by the project entitled “Knowledge transfer platform FindFISH – Numerical Forecasting System for the Marine Environment of the Gulf of Gdańsk for Fisheries” (no. RPPM.01.01.01-22-0025/16-00) funded by the European Union through the European Regional Development Fund within the Pomorskie Voivodeship Regional Operational Programme for 2014–2020.

Keywords

Baltic Sea, fisheries forecasting, hydrodynamic variables, numerical model

P3.04

Comparative of the growth rates of the genetically improved farmed tilapia (GIFT) using formulated sweet potato granules and commercial feeds

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Abstract

Background: The issue caused by the amino acids from the costly fish feed in the growth of Genetically Improved Farmed Tilapia is the incredible cost of fish feeds. The study aims to look for an alternative and cheap fish feed. The research identified Genetically Improved Farmed Tilapia (GIFT) growth rates in the HAPA using formulated sweet potato granules and commercial feeds for 60 days as basis for the development of a Technology Guide. The experiment method has been used in the research.

Results: The findings showed that the three formulated feeds have lower protein (20.33, 19.3, and 19.6) yet with higher fat (24.1, 15.69, and 10.72) than the commercial (24.1%, 3%). The initial and final weight in grams, length in centimeters and width in centimeters were highest on T1 then followed by T2 and T3. It was with the use of T1 which proved to be an effective feed.

Conclusion: The ingredients utilized in the feed formulations are possible substitution of fish feed and the advancement of its usage is commendable.

Keywords

Formulated Feeds, Genetically Improved Farmed Tilapia, Fish Feed

P3.05

Sustainable environmental education activities through a holistic approach - "Global Citizenship Education" and "Transformation of Inner Self"-

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Abstract

Located in Hamamatsu - one of Japan's leading industrial cities - our technical high school has been engaged in practical environmental education activities since 1991, and in 1995, established our Environmental Club for developing student-leaders.

We have been working on environmental education with a focus on creating a sustainable society based on the teachings of three famous Japanese educators;

- Tsunesaburo Makiguchi, believed the then current military, political, and economic competition would give way to a new form of competition which he called "Humanitarian Competition" based on the relationship between nature and society.
- Josei Toda stated that humanity is one, sharing a common fate, and that each and every person needs to be aware of their responsibilities as a "Global Citizen."
- Daisaku Ikeda believes that the key to achieving real change on a global scale is the transformation of the individual, called the "Human Revolution."

Each teaches the importance of "Global Citizenship Education" and the transformation of one's inner self. We place importance on environmental education activities that value "Small Steps for Each Person."

Our main activities in the beautiful native area of Lake Hamana, which is an enclosed sea area, the associated Lake Sanaru and Nakatajima Sand Dune basins, include nature conservation activities, cleaning operations, tree planting activities, and surveying activities.

While there are technical and scientific aspects to our program, we add a holistic, humanistic aspect to it with the principal of creating individuals to be responsible environmental citizens and to teach this responsibility to others. Our students expand the “Circle of Empathy” to friends, family, and the local community and teach the importance of the “Sustainable Society”.

We are also expanding "Global Citizenship Education" to make "SDGs" a global value.“Education” for children that makes “SDGs”, including climate change, a common value throughout the world are extremely important.

Keywords

SDGs , Global Citizenship Education, Humanitarian Competition, Human Revolution

P3.06

Nutrition management inferred from the marine environmental changes in Osaka Bay, Japan

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Abstract

Introduction:

The Seto Inland Sea Environment Conservation Basic Plan is a plan that should be the basis for the conservation of the Seto Inland Sea environment, which is formulated by the government based on Article 3 of the Seto Inland Sea Environment Conservation Law. It is a remarkable point that as a change (revision) content regarding "water quality conservation", in addition to conservation for preventing water pollution, the viewpoint of "management" has been added to the goal of water quality conservation.

Methods and Results:

Osaka Bay, which is the focus of this study, is a characteristic sea area in the Seto Inland Sea where the balance of nutrients in the inner part of the bay (overnutrition) and offshore (nutrient deficiency) has recently been pointed out, and following Tokyo Bay and Ise Bay, it is positioned as a closed sea area where environmental management should be tackled. In this study, we performed an environmental evaluation using a multiple regression model, and these graphs showing the normality of the model, the variance, the data order and the stability of the estimated red tide index showed a state with a contribution rate of about 80%.

Discussion:

Unlike Tokyo Bay and Ise Bay, Osaka Bay is characterized by the fact that regulations have been strictly enforced for a long time, including the achievement rate of environmental standards and red tide show various changes such as increase, decrease and leveling. Utilizing this unique feature of Osaka Bay, a model focusing on the “Three Fluctuation Periods of the Red Tide” and “Various Regulations” was created to compare environmental changes. We found a useful solution to promote the sustainable development of "Osaka Bay" and "conservation and management of water quality".

Keywords

Red Tide, Sustainable Development, Osaka Bay, Seto Inland Sea

P3.07

A global perspective of the impacts of climate change on coastal brownfield and solid waste disposal sites

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Abstract

This paper reviews the impacts of climate change on pollution sources and pathways in coastal brownfield and waste disposal sites, and the consequences for water quality and surrounding ecological and community health, including: 1) Brownfield and waste sites in low-lying coastal zones may be flooded due to sea-level rise and pollutants, which are currently isolated from the marine environment, and may be mobilized and released. An increase in temperature, moisture content and salinity in inundated landfills may both enhance and inhibit microbial activity, potentially resulting in changes to biogas productionand organic pollutant biodegradation rates. The temperature, salinity and pH of soil and groundwater will change after flooding and sea water intrusion, thus changing the toxicity and mobility of heavy metal and degradation rates of organic contaminants such as polycyclic aromatic hydrocarbons. Saline intrusion will also modify sub-surface hydrology and cause soluble pollutants in the soil to move as less dense fresh water rises; 2) An increase in intensity and frequency of extreme weather, such as heavy rainfall, and extreme storm and flood events will accelerate erosion and has the potential to resuspend and remobilise both particulate and soluble pollutants. Erosion will lead to damage of these coastal structures and further release of particulate pollutants and solid wastes. Leakage of solid waste from landfills can adsorb metals and organic pollutants, and will significantly affect its transport, whilst exposure of solid wastes to the aerobic and high energy marine environment may accelerate their physical and photodegradation; 3) More widespread pollution and frequent extreme weather conditions will lead to more frequent public health emergencies, posing a threat to water security, physical and mental health of surrounding residents. When terrestrial pollutants such as persistent organic substances and emerging pollutants are released into the ocean, the scale of the impacts on marine ecosystems are unknown.

P3.08

Mapping the rocky intertidal community using UAV imagery, challenges and achievements

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Abstract

This study is part of the EU funded project POSEUR-03-2215-FC-000046 and focuses on the Algarve S/SW coast, covered by the Sudoeste Alentejano and Costa Vicentina Natural Marine Park (SACVNMP). This project aims to create a monitoring program for the park by standardizing the monitoring indicators, methods and procedures which prove to be the most cost-effective, considering the conservation objectives.

Mapping marine habitats and communities is currently one of the primary steps for coastal management, assuring the availability of refined workbases for change detection across time and space (Godet, Fournier, Toupoint, & Olivier, 2009). Drone visual censuses are being adopted in response to the need for an easily replicable and accessible method for large-scale coverage, by recording high-resolution aerial images through low-altitude flights and, simultaneously, generating three-dimensional coordinates of the sampled surface (Murfitt et al., 2017). The combination of traditional sampling methods and modern habitat mapping with UAV (Unmanned Aerial Vehicle) is currently being tested in rocky intertidal survey programs in the northern Gulf of Alaska (Konar & Iken, 2016, 2018), in the *Mareano*'s habitat mapping program in Norway (Kanstad & NMA HS, 2017), and in other scientific outputs from the coast of Victoria (Australia, Murfitt et al., 2017), among others. Nonetheless, scientific production is still sparse, given the experimental nature of this method. We found it to be effective for mapping important groups in the rocky intertidal community, their distribution and characterization it in two spatial scales. This is one of the few studies to map an intertidal community, without focusing on a particular organism. It should be noted that the vertical stratification verified with the squares technique, as well as the dominance of some taxonomic groups (eg, calcareous coralline algae and barnacles *Chthamalus*) is evident in the produced classified images, including its vertical stratification.

Keywords

remote sensing, intertidal community, Habitat mapping, monitoring program

P3.09

Living stromatolites as past and present coastal refugia

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Abstract

Recently-discovered examples of ancient stromatolite ecosystems forming on the South African coast offer glimpses into life's adaptions, changes and responses to past divergence and extinction events. These habitats, which are built by a range of microbial organisms and microalgae, have existed from as far back as 3.5 billion years ago and represent the most longstanding and uninterrupted record of ecosystem resilience on Earth. The South African stromatolite communities are one of very few examples of such structures that are actively accreting today. Exactly what the societal relevance of these living examples are and how they could help us to understand past climate change, coastal processes and species adaptations is being uncovered. The South African stromatolites represent a biodiversity refuge for many species, hosting some unknown and unusual taxa that include the recently discovered tanaid *Sinelobus stromatoliticus*, which seems to be endemic to these habitats. This has suggested that the unique environmental conditions provided by the stromatolites may be acting as micro-evolutionary conduits for species change. On the other hand, species that are associated with different environments (such as estuaries) or even those from a disparate geographical range have been observed in the stromatolites, especially amongst the fish community. Finally, there is also evidence to suggest that the South African stromatolites acted as stepping-stone freshwater refugia for early modern humans along the Palaeo-Agulhas Plain margin. These findings represent a diverse, multidisciplinary range of refugia utilisation linked to possible mechanisms of species adaptations and divergence processes. Results from these explorations will be presented.

Keywords

microbial mats, extant microbialites, connectivity, stepping-stone habitats

P3.10

Alimentary strategy in Diplodus annularis Linnaeus, 1758 (Teleostei: Sparidae) and Mullus surmuletus Linnaeus, 1758 (Teleostei: Mullidae) in the area of artificial reef in Asinara Gulf (Sardinia, Italy)

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Abstract

Antitrawlingc artifacts were placed, in an area of Asinara Gulf, with the aim of protecting a submarine cable of SAPEI electrical Project.. In this context, an environmental monitoring plan has been developed, in order to evaluate changes in feeding habits of two target species, between control and impact sampling sites (3 replicates each), both stratified by two depth strata

On the whole, 293 *Diplodus annularis* and 160 *Mullus surmuletus,* collected in 5 seasonal fishing scientic surveys, were analyzed,. *resulting in*45 stomachs for *D.annularis* and67 for *M.surmuletus* actually containing prey items.

Prey items found in stomachs have been identified at the lowest taxonomical level possible and their numerical abundance was analysed using the main community structure indices, as well as through multivariate statistics techniques. Based on frequency of occurrence and relative abundance, Costello's chart was used to interpret the importance of prey and the food strategy of the target species.

The analysis of the stomach contents of *D. annularis* and *M. surmuletus* showed a diet consisting essentially of Crustaceans (especially Decapods and Amphipods), Polychaetes, Molluscs and Echinoderms with variable percentages.

Analyzing the data as a whole, it is possible to hypothesize for *M. surmuletus* a feeding preference for the taxon of the Echinoderms, chiefly the species *Echinociamus pusillus.* Crustaceans represent the most abundant prey. Factors such as bathymetry, season or the presence of structures are discussed as variables potentially affecting feeding preferences in the context of our data.

Keywords

Diet variation, Mullus surmuletus, Diplodus vulgaris, Antitrawling artifacts

P3.11

Monitoring 20-year inter-regional changes in phytoplankton biomass off the Antarctic Peninsula using ocean colour remote sensing

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Abstract

The marine ecosystems off the Antarctic Peninsula are amongst the most impacted by climate change, particularly by ocean warmth and ice melting. One of the main predicted consequences for marine communities are structural changes to the water column, such as increased stratification. Consequently, changes in the structure and composition of more sensitive biological communities, such as phytoplankton, have already been observed. Due to their vital role as the main marine primary producers, it becomes instrumental to monitor phytoplankton biomass and community changes. However, in-situ sampling in the Antarctic Peninsula is scarce, discrete and, typically, highly limited in time and space. Ocean colour remote sensing (OCRS) can complement in-situ data, enabling a continuous flow of data with good spatiotemporal coverage. While sea ice and cloud coverage are strong limitations, the advent of robust, high-resolution, multi-sensor ocean colour products will contribute to establish OCRS as a tool to monitor phytoplankton in Antarctic waters. This work takes benefit of two robust in-situ (10-year) and remote sensing (20-year) datasets to evaluate changes in phytoplankton biomass. Analyses performed were focused on phytoplankton biomass, uncovering its seasonality and identifying and extracting summer trends and anomalies across the Antarctic Peninsula. Subsequently, specific regions were evaluated through OCRS and compared with the in-situ data collected during summer cruises. Results exhibit significant inter-regional variability, as distinct characteristics and trends were observed. Results are expected to contribute to the existent knowledge on biological communities in the Antarctic Peninsula, establishing OCRS as an essential tool for monitoring the Antarctic ecosystem.

Keywords

North Antarctic Peninsula, phytoplankton, ocean colour remote sensing

P3.12

Mnemiopsis leidyi swarms shape microbial microhabitat conditions in the coastal waters of the north-eastern Adriatic

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Abstract

Seasonal blooms of invasive ctenophore *Mnemiopsis leidyi* have become a regular phenomenon in the north-eastern Adriatic (NEA), threatening the pelagic food web and potentially altering the ecosystem dynamics.

We hypothesise that ctenophore blooms can trigger substantial changes in carbon compounds and nutrient availability, leading to structural changes in the microbial community. Thus, we analysed the response of the microbial community *in situ* – inside and outside of *M. leidyi* swarms, from August-December 2020 in the coastal waters of Rovinj-Rovigno, NEA.

Ctenophora abundance was enumerated by visual census. Heterotrophic prokaryotes (HP), cyanobacteria (CB) and heterotrophic nanoflagellates (HNF) were counted by epifluorescence microscopy. Total prokaryotic community composition was determined after eDNA isolation, amplification of 16S rRNA marker gene (V1-V3 region) performed on Illumina MiSeq. Data were analysed using QIIME2 processing pipeline, with taxonomic classification at the order level using SILVA database. Nutrients (orthophosphate, nitrate, nitrite, ammonia, total N and P) were determined spectrophotometrically, dissolved organic carbon (DOC) was measured by standard HTCO method and its surface-active fraction by electrochemistry.

Ctenophora in swarms ranged from 20-400 *M. leidyi*/m^3. Microbial abundances, nutrients and carbon content displayed consistently higher concentrations within swarms. Prokaryotic community structure did not show statistically significant differences between the swarms and controls, yet, in most swarms, the shares of Alphaproteobacteria Rhodobacterales increased while Puniceispirillales, Rhodospirillales, SAR11 clade and Gammaproteobacteria SAR86 clade moderately decreased.

In conclusion, *M. leidyi* swarms can alter microhabitat conditions stimulating the growth of HP through increased availability of highly labile and surface-active DOC and CB by the release of ammonia, nitrate and orthophosphate. HNF abundances increase with the higher availability of their prey (HP and CB). The prokaryotic community structure displayed only mild changes, probably due to the episodic nature of the swarm formations impeding a consistent bacterial succession.

Partly support of the project MARRES is acknowledged.

Keywords

Mnemiopsis leidyi, microbial community, organic carbon, nutrients

P3.13

Modelling habitat suitability for twaite shad in the estuaries of Elbe and Weser (Germany)

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Abstract

Abundances of twaite shad (*Alosa fallax*) and its larvae in the estuaries are of major importance in the evaluation of river ecosystems due to its protection under the EU's "Habitats Directive". Therefore, egg and larvae numbers of twaite shad are monitored in the estuaries of the rivers Elbe and Weser during the last decade. This study aims to model suitability for spawning and larvae growth of twaite shad within the Elbe and Weser estuaries.

Modelling was conducted for the years 2011 to 2018, whereby expert knowledge was incorparated into a rule set expressing twaite shad's ecological requirements in the estuary. These rules were combined in a fuzzy logic system and applied to modelled environmental conditions, resulting in habitat suitability scores for both spawning and larvae development. Validated environmental conditions were gained from the water quality model QSim and contained spatial and temporal distribution of both biotic and abiotic variables (such as temperature, oxygen, prey and others) within both estuaries.

The modelled suitability scores show intraannual and interannual variations along spatial gradients and indicate most suitable areas are to be found within km 580-660 (Elbe) and km 0-50 (Weser) in spring and summer time. These areas are consistent with actual spawning areas of twaite shad observed in monitoring campaigns. Model and observation data will be connected to evaluate the match-mismatch-hypothesis for fish larvae of twaite shad. Additionally, an interactive web app was written to visualise and explore model results. It provides a valuable tool to identify the causes for declining twaite shad larvae numbers and could support water management or renaturation strategies.

Keywords

Weser, Elbe, twaite shad, fuzzy logic

P3.14

Zooplankton dynamics in the elbe estuary (germany) with respect to being prey for fish larvae

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Abstract

Zooplankton plays a key role in food webs in many aquatic environments, including estuaries. It is considered to be the main food source for fish larvae, like the anadrome twaite shad (*Alosa fallax*) whose larvae are hatching in the estuarine part of the Elbe, Germany.

Three different sets of zooplankton sampling campaigns were conducted in the Elbe estuary during 2010-2019. The first set included longitudinal profile campaigns, conducted twice a year, taking zooplankton samples every ~4 km from the border of the North Sea at km 750 to end of the fresh water zone of the tidal river at km 585. Salinity was measured constantly and zooplankton set in context to different salinity zones.

The second set included monthly to weekly zooplankton sampling in the freshwater zone at km 628 from March to November. Findings were analyzed by seasons.

The third set were sampled, along with twaite shad eggs and larvae sampling, weekly zooplankton samples from middle of April to middle of June, at km 643. Fish larvae numbers were set in context with zooplankton biomass and abiotic conditions such as water temperature, oxygen and river discharge.

The zooplankton biomass of the whole estuary is clearly dominated by crustacean, although rotifers dominate abundance in the fresh water zone. Of all taxa, nauplius larvae are clearly dominating in abundance at all salinity zones. Zooplankton biomass and abundance is highest during summer at km 628. Whereby, the zooplankton abundance at km 643 is decreasing over time. Along the spawning area of twaite shad (km 630-660) and during spawning time (April to May) beside nauplii, the copepodits and adults of *Eurytemora affinis* dominate the biomass.

In general, the findings prove intra- and interannual variations of zooplankton biomass, which can be explained by biotic factors such as prey – predator interaction and by abiotic factors.

Keywords

Zooplankton, Fish Larvae , Elbe estuary , Weser estuary

P3.15

Assessment of multiple biodiversity components revels new perspectives on conservation for marine fishes in the north-eastern tropical Brazilian continental shelf

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Abstract

Biodiversity is the foundation of ecosystem processes to which all species are intimately connected. The diversity of communities is traditionally assessed by species richness and eveness. Yet, there is a growing interest in considering complementary components dealing with species differences, notably based on their functions within the ecosystem, for which taxonomic distances (mainly drawn from morphological features) can be a proxy It may contribute, for instance, on a better identification of priory areas for conservation (PAC). Biodiversity indices related to multiple components (species and taxonomic diversities) were computed to investigate spatial patterns of demersal fish assemblages along the north-eastern tropical Brazilian continental shelf (TBS; 9°-5°S). In addition, to evaluate the contribution of nestedness/turnover in the species composition within the study area, a partitioning analysis of beta diversity was performed, based on species presence-absence. Two large-scale multidisciplinary oceanographic surveys (ABRACOS I, II) provided underwater footages and bottom trawl samples for our analyses. A total of 121 species were collected. Alpha diversity was higher at the deepest habitats (30–60m), near to the shelf-break and coralline formations. However, the taxonomic diversity and distinctness were higher in the shallowest habitats (10–30m), close to estuaries mostly composed by sand. Additionally, beta diversity demonstrates a substitution of species (turnover =0.982/nestedness =0.018), which highlights a shift in the species composition throughout the study area from north to south. High alpha diversity in deeper environments points out this location as PAC. Conversely, the shallowest habitats contain species that are more taxonomically distant, which agrees with species turnover, and may express the presence of species with different ecosystem functions. Coastal habitats are traditionally highly vulnerable to anthropic impacts, but here not considered as PAC. These results indicate that conservation of shallower habitats nearby estuaries along the TBS is also critical to consider.

Keywords

fish diversity, demersal fish, beta-diversity, priory areas for conservation

P3.16

Strategies and tools to reduce and mitigate the effects of negative human-shark interactions

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Abstract

The conflict between humans and large predators is an enduring challenge entailing negative consequences for both humans and wildlife. With personal safety and food provision representing long-standing priorities, assuring the health of marine ecosystems is paramount for the long-term sustainability of ocean-uses. Often feared or viewed as a nuisance, sharks play essential functions in marine ecosystems and are key to the balance of marine food webs. Sharks also are among the most vulnerable animals in our ocean with overfishing (target and bycatch) standing as the greatest threat to shark species and populations worldwide. Besides the ecological impacts stemming from the loss of apex predators, bycatch and depredation in fisheries result in substantial economic loss. Meanwhile, tourism further increases the pressure over sharks due to both hazardous tourism operations and measures aiming to decrease the incidence of shark attacks, which represent a serious threat to both human-life and may affect local businesses in coastal recreational areas that largely depend on tourism. In this context, we review and discuss the mitigation strategies aiming at reducing the frequency and mitigating the detrimental effects of shark-human interactions, including: (1) the implementation of regulations to develop sustainable fisheries; (2) alteration of fishing behavior/gear to reduce bycatch; (3) strategies to decrease spatio-temporal overlap (with lethal and non-lethal methods) (4) shark deterrents and stimulus dissimulating gear and (6) tools that minimize the adverse effects of an interaction. With increasing ocean use, it is urgent that we curb damaging practices and set-aside fear-based outlooks that complicate conservation efforts and embrace human ingenuity to promote more sustainable strategies.

Keywords

Sharks, Sustainability , Mitigation, Human-shark interactions

P3.17

Ecosystem functioning approach as a tool for sustainable management of semi-enclosed contaminated coastal areas

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Abstract

The ecosystem approach to management (EAM) of the marine and maritime space remains still more of a concept which is widely discussed at scientific fora, but with very few examples of actual practise. To provide practical support to decision makers in the spatial planning of a harbour and/or highly polluted area, the EAM was applied to three Sites of National Interest (SIN), i.e. very large contaminated areas classified as the most dangerous by the Italian State and in need of remediation, one located in the lagoon of Grado-Marano, one in the port of Trieste (both in the northern Adriatic Sea), and one in the Mar Piccolo of Taranto (Ionian Sea).

To assess the ecosystem functioning, a holistic approach was followed by integrating the ecosystem structure, its functioning and biological diversity at several trophic levels, in the sediments as well as in the water column (only in the last case study).

In the Grado-Marano lagoon we observed an extremely active microbial community at the most contaminated site that ensured high production and degradation rates, indicating an ongoing bioremediation process, resulting in a technical decision against the dredging of the area.

In the port of Trieste, we observed a particularly biodiverse, structured and productive benthic community in one part of the SIN that could be therefore extrapolated from the SIN and its regulations.

In the Mar Piccolo, in contrast, the sediments within the navy arsenal were so strongly polluted to reduce the abundance at all trophic levels and interfere with the proper functioning of the benthic ecosystem, indicating that dredging of this particular area would be an appropriate intervention.

Our findings show how the correct assessment of the ecosystem functioning in polluted areas may represent a useful tool for their management in order to plan environmental interventions in a rational way.

Keywords

ecosystem approach to management , contamination, Site of National Interest , semi-enclosed area

P3.18

Beta diversity in coastal macroinvertebrate assemblages from the semi-enclosed harbor area of Trieste (northern Adriatic sea).

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Abstract

We analyse the diversity of benthic macrofaunal assemblages collected during the last 20 years in the Port of Trieste which is subjected to industrial and other anthropogenic pressures that lead to high accumulation of contaminants. With the assessment of α (Shannon 'diversity) and β (BD_{area} and BD_{total}) diversities, and the Species Contribution to Beta Diversity (SCBD), we can understand the biodiversity conservation of the local macrofaunal communities influenced by contaminants. We analysed these assemblages from two macrosites, characterized by different anthropogenic pressures: the 'industrial plants' site, with 6 stations which corresponded to the heavy contaminated part of the port, whereas the less impacted stations (4 in total) were gathered in the 'residential' microsite. The abundance ranged from 996.2±558.0 to 1507.2± 705.9 ind. m^{-2} at the 'industrial plants' site and 'residential' one, respectively. For α diversity, a low value (H'=3.7±0.6) was observed at the heaviest contaminated area, whereas the highest diversity was noticed at the 'residential' one (H'=4.6±0.5). The two areas significantly differed in terms of total number of species, H' and species composition. BD_{total} was equal to 0.73, whereas the values of each area varied from BD_{area}=0.62 in the 'industrial plants' area to BD_{area}=0.67 in the 'residential' one. Surface deposit feeders (SDF) contributed to the highest SCBD values, indicating that SDF strongly influenced the β diversity in two microsites. However, in the 'industrial plants' area, we observed the highest contribution of SDF to SCBD, whereas, in the 'residential' one, a more balanced role of other feeding guilds contributing to β diversity was noticed. In the 'industrial plants' area the presence of contaminants might have influenced the local (α) and regional (β) diversity. Furthermore, the high contribution of SDF to SCBD could be linked to the presence of stress-tolerant species that are mostly deposit feeders.

Keywords

benthic assemblages, Beta Diversity, port of Trieste, industrial pollution

P3.19

Selective potential of geotextiles on marine fouling settlement

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Abstract

In recent years, the prevention of coastal erosion due to the action of waves, currents, tides and organisms has arisen as a top priority for reducing the damage to structures and loss of lands. Climatic change is making the erosion rates worse by increasing in storm frequency and intensity. The high coastline recession rates cause significant concern in heavily populated locations. New tools for application in hydraulic engineering are represented by nonwoven geotextiles. These materials are made of polypropylene (PP) and polyester (PET) fibres, have physical and hydraulic properties, which are useful in artificial structures for coastal protection as an alternative to natural hard substrates. On the other hand, they could interfere with the settlement of fouling species in respect of natural substrates. To better understand the potential effects of geotextiles on the colonization capability of fouling organisms, a 10-months study was carried out in the Lagoon of Venice (Italy), a particular environment of temperate transitional waters with high biodiversity. Three different needle punched staple fibre geotextiles were chosen from Naue GmbH & Co. (Germany): 1) Secutex R601 (white PP), 2) Secutex 251 GRK 4C (hot-calendered white PP and PET), and 3) Terrafix B 609 (multi-layered coloured PP and white PET). Fouling settlement was monitored and analysed on panels replaced monthly and compared with the colonization on wood panels as a reference substrate. All geotextiles revealed a negative effect on the settlement of green and red algae, bivalve molluscs and barnacles. Secutex R601 and Terrafix B 609 also inhibited the settlement of serpulids. Conversely, they showed a positive selective effect towards various ascidian species. The loss of pivot species in favour of the selection of dominant and/or invasive species could trigger negative consequences in both trophic chains of coastal ecosystems and in economical relevant activities of fishing industry and aquaculture.

Keywords

Artificial substrates, Coastal erosion, Macrofouling community, Nonwoven geotextile fabrics

P3.21

Environmental harmfulness of lost fishing gear in the NW Portuguese coast – the NetTag project

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Abstract

Lost fishing gear at sea, mainly composed of plastics, threatens greatly marine ecosystems. Although inert, environmental dynamics can induce modifications on its surface, making it suitable to adsorb pollutants, or even promote plastics degradation which can result in the production of microplastics. Moreover, plastic debris provide a substrate for microbes, making them a possible transportation vector for biological pollutants such as opportunistic pathogens. To better understand the ecological implications of fishing-related debris, NetTag project is studying the environmental harmfulness of lost fishing gear as a new pollutant.

In this work, chemical (metals, PAHs, microplastics) and microbiological (pathogens) contaminants were analyzed in two hotspots of lost fishing nets located along the NW Portuguese coast, both with intensive fishing activity: (i) Cavalos de Fão, a natural rocky bottom area, with several reefs; and (ii) Matosinhos submarine wreck, an artificial reef. Samples of water, sediment and lost nets were collected from both sites, for chemical monitoring of metals and PAHs, and also for microbial community analyses by next-generation sequencing.

Overall, low levels of metals and PAHs were found at both sites, showing that both water and sediments were not polluted by metals or organic contaminants. No clear influence of lost fishing nets was observed on these contaminants levels. Matosinhos submarine presented a higher level of microplastics contamination, mainly fibers, and further analyses are being done to characterize the plastic polymer and ascertain the source of those microplastics. Microbial communities associated with lost nets, were sequenced and are being were analyzed to investigate the occurrence of pathogenic bacterial groups.

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Keywords

ghost gear, marine pollution, plastic debris, pollutants

P3.22

Characteristics of microplastics in rivers and estuary in Takamatsu, Kagawa in May -October, 2019

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Abstract

In recent years, river pollution is getting worth by releasing microplastics and the microplastics is paid much attentions for global and local environmental issues. However, we have little information about microplastic in river and estuary because these areas are in topographic border area. The purpose of this study is to clarify the characteristics of microplastics in rivers and estuary in Takamatsu City, where is located in the Seto Inland Sea. The methods are as follows. 1)The suspended matter was collected by a plankton net (mesh size is 350 um) in May – October, 2019. 2)Various pretreatment methods were examined to take microplastics from the collected suspension. 3)After the pretreatment, substances were sorted by hands. And, we discriminated the type of the plastics by using a FTIR (Fourier Transform InfraRed spectroscopy). 4)The area-equivalent particle size of the samples was measured by image analysis. The conclusions are as follows: 1) Microplastics existed in rivers and estuary in Takamatsu City. 2) The types include PE, PP and PS, and a total of 8 types were identified. The most dominant type was PE, accounting for about 60%. 3)The most dominant size was 0.25-0.87 mm in diameter. 4) The number concentration of microplastics in estuary was higher than in rivers. 5) At the time of flood, the number concentration of microplastics in river increased. 6) River sediment also contained microplastics.

Keywords

Gobo river, Shin-kawa and Kasuga-gawa tidal flood, PE, medium-sized city

P3.23

Project UAS4LITTER - Using drones to map marine litter on sandy beaches

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Abstract

Unmanned Aerial Systems (UAS/Drones) are great resources for search operations as they allow for remote examination of vast areas. Marine litter is ubiquitous in marine and coastal areas and the assessment of their levels and distribution a key issue for the implementation of mitigation plans. In this project, low-cost UAS has been used for detecting and mapping marine litter in coastal areas using as study sites three sandy beach-dune systems from the eastern Atlantic coast (Portugal) with different loads of marine litter.

To date, several technical solutions have been tested by a multidisciplinary team in terms of drone mapping performance, manual image screening and marine litter map analysis. The experiences of this project show that commercial off-the-shell UAS allows an integrated framework for marine litter mapping comprising: 1) a fast snapshot of the loads of macro litter items (> 2.5 cm) on the shore; 2) an automatic detection of marine litter using machine learning techniques and 3) the characterization (type, colour and size) of marine litter also on protected areas (dunes).

In parallel, dissemination and outreach activities have been implemented during the first two years of the project to improve awareness and knowledge on the risks posed by marine litter and on measures to map, quantify and reduce its impacts and to inform key stakeholders.

Keywords

Drones, coastal areas, marine litter, plastic pollution

P3.24

Are existing modelling capabilities sufficient to guide evidence-based management of estuaries under climate change?

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Abstract

Estuaries and surrounding low-lying coastal communities, including over 600 million people worldwide, are among the most susceptible systems to sea level rise (SLR). SLR implications include more frequent oceanic inundation, shoreline erosion, and the failure of stormwater and drainage infrastructure. To predict and manage these potential impacts, a comprehensive understanding of how an estuary, as an entire waterbody, responds to SLR is required. However, recent research highlights that static (or bathtub) approaches are still widely used to assess SLR impacts in estuaries, although they fail to consider important real-world tidal dynamic effects (e.g., amplification, dampening, resonance). Where advanced hydrodynamic models have been applied, an improved understanding of altered estuarine tidal dynamics has been gained, particularly regarding future high tide levels (i.e., the level of high tide after SLR) and the associated inundation of adjacent lands. However, limited knowledge exists regarding the altered estuarine hydrodynamics under SLR and how it interacts with and influences geomorphology, ecology, and bio-geochemical processes. This is despite the fact that there is currently a shift towards more holistic, whole-of-system management of estuaries, which requires an in-depth understanding of temporal and spatial variations in hydrodynamics (e.g., tidal range), ecology (e.g., vegetation composition), water quality (e.g., saltwater intrusion), and geomorphology (e.g., dredging) at the system scale. Extensive interdisciplinary research is required to reduce (or eliminate) existing uncertainties in estuarine numerical modelling tools and provide accurate information to policy makers to better develop sustainable, evidence-based management strategies for these highly valuable ecosystems.

Keywords

Sea level rise, Estuary management, Tidal dynamics, Hydrodynamic modelling

P3.25

Mangrove interaction with tidal flow, waves & long term sedimentation: mechanisms governing adaptation

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Abstract

The uncertainty surrounding the impact of sea-level-rise (SLR) and storms, which threaten the coastal hinterland, heightens the need for design guidelines on mangroves adaptation and their use in coastal safety. This research seeks to quantify the bio-physical processes governing the geomorphological evolution of mangrove-mudflat systems utilizing spatially explicit observations of mangrove population dynamics with process-based modelling. For calibration purposes and increased insight into the interactions between hydrodynamics, sediment dynamics and mangroves, field observations were collected along Guyana's coast.

A quadrant, 1km wide and 6km in length, was established along the mangrove-mudflat coastline at Chateau Margot. This stretch of coastline is subject to a semi-diurnal tidal regime with maximum tidal range of 3.5m during spring tide. Using the data, we developed a 2D high-resolution depth-averaged model of the field site using Delft3D-Flexible Mesh. We coupled this model with a mangrove dynamics model capturing the development of the Avicennia germinans and Laguncularia racemosa species under suitable inundation and competition regimes. The coupled model stimulates the geomorphological development from the interaction between the intertidal flow, waves, sediment transport and the temporal and spatial variation in the mangrove growth, drag and bio-accumulation over 100 years.

Waves are critical for the transport of mud into the mangrove belt during high tide. Inundation of the inner fringe occurs during spring tides, so the calm conditions allow for a heightened platform and species establishment. The deeper channels form the major path for the tidal inflow during the lower tides, while the interior of the forest is an effective sediment sink during the higher tides. RCP 4.5 and 8.5 SLR scenarios simulate the retreat and decay patterns, with modeled tipping points realized after 1.5m.

Results indicate mangrove adaptability hinges on the long term sedimentation responses and system conditions to promote the establishment of belt widths exceeding 300m.

Keywords

mangroves, adaptation, sea level rise, field measurements

P3.26

Brackish bulrush marshes in the Fraser River estuary (British Columbia, Canada) are disappearing at a rapid rate

Sean Boyd

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Abstract

The Fraser River estuary is the largest and most important estuary in British Columbia, Canada and one of the most important ecosystems on the entire Pacific Coast of North America. The estuary supports hundreds of thousands of overwintering waterfowl, millions of spring migrating shorebirds, and hundreds of millions of out-migrating juvenile Pacific salmon. The low elevation tidal marshes, in particular common three-square bulrush (*S. pungens*), have experienced significant biomass declines in recent years and large parts of the estuary have reverted to mudflats. In addition to the negative consequences for the myriad of fish and wildlife species dependent on the estuary, the biomass declines are likely having significant negative effects on carbon sequestration and dike protection. A large and increasing population of Snow Geese overwintering on the estuary is largely responsible for the biomass declines via their intensive grubbing behavior on bulrush rhizomes. However, increasing numbers of Canada Geese, sea level rise, dike/jetty construction, and river dredging are also likely contributing to the declines. These proximate and ultimate factors must be addressed in a rigorous scientific manner to ensure that the estuary remains productive and functionally intact.

Keywords

bulrush, rhizome, geese, estuary

P3.27

Seagrass (Zostera noltii) fatty acid remodelling induced by warming and acidification

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Abstract

Dwarf eelgrass *Zostera noltii* meadows are found in estuarine coastal areas across the north-eastern Atlantic, where they provide key ecosystem services, including nursery grounds, sediment stabilization, nutrient cycling and carbon sequestration. These blue carbon ecosystems are being subjected to several anthropogenic pressures, including climate change-related effects. In this study, we investigated biochemical changes (fatty acid profiling) under different climate change scenarios, namely: i) control (18 °C, pH 8.0); ii) acidification (18 °C, pH 7.6); iii) warming (22 °C, pH 8.0) and iv) combined warming and acidification (22 °C, pH 7.6), following IPCC RCP scenario 8.5. Significant modifications in the percentage of saturated (SFA) and polyunsaturated fatty acids (PUFAs) in response to warming and low pH levels were detected. The changes suggest a rearrangement of membrane composition in order to maintain membrane fluidity, specially under warming conditions. Thus, fatty acids proved to be a good biomarker to detect changes in seagrass ecophysiology under acute climate change-related events. Our findings suggest that future global warming will pose a serious threat to these already endangered blue ecosystems.

Keywords

Seagrass, Zostera noltii, Climate Change, Fatty acids

P3.28

Predicted impact of climate change on the distribution and habitat suitability of dwarf eelgrass (Zostera noltii)

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Abstract

Coastal environments are under severe threat from recent climate change. Despite increasingly recognized for being some of the most productive ecosystems and for their vast array of life-sustaining ecological services, recent studies show that these areas harbor some of the world's most threatened ecosystems. In fact, nearly half of salt marshes, 35% of mangroves, and 29% of the world's seagrass beds have disappeared in the past half century, and it is expected that the impacts of anthropogenic pressure and climate change will increase in the near future. Seagrass meadows are composed of marine flowering plants widely distributed across marine coastlines and estuarine environments. They form complex physical structures which are highly productive and support considerable biomass and a vast diversity of associated species. The eelgrass *Zostera noltii* is a common species in seagrass meadows along the eastern Atlantic Ocean and the Mediterranean Sea. It is known to be particularly vulnerable to climate change and anthropogenic pressure. The ability to predict the potential susceptibility of seagrass species to climate change is invaluable to the correct environmental management of these transitional areas in the mid to long term. Within this context, the present study modelled and analyzed the potential changes to the present and future distribution of *Z. noltii*. For this purpose, species distribution models were applied on occurrence data in conjunction with environmental predictors (i.e., sea surface temperature, salinity, current velocity, and sea level) to determine the present habitat suitability and species distribution, together with their potential change in the future (i.e., 2050, 2100) across four representative concentration pathway scenarios (CMIP5: RCP26, 45, 60, and 85). This species appears particularly vulnerable to climate change, with significant reductions in habitat suitability and changes to its distribution being predicted.

Keywords

Zostera noltii, Climate Change, Species Distribution Models, Seagrass

P3.29

Synchronous effects of climate variability on fish larvae and juveniles in an estuarine nursery

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Abstract

Marine ecosystems are being drastically affected by climate change and its pervasive effects on marine organisms. Indeed, species vulnerability to climate change depends mostly on their most sensitive stages to climate-induced bottlenecks, which for marine fishes also includes larval and juvenile stages.

In this study, we used 13 years (2003-2015) of continuous monthly sampling in the Mondego estuary (Portugal) to better understand the effects of climate variability on larval and juvenile fish assemblages. In total, we identified 31 larval and 47 juvenile species, and grouped both life stages into ecological, feeding mode and vertical distribution guilds to account for the long-term effects on ecosystem functioning. Then, mean annual abundances were related with dominant local- and large-scale climate drivers.

We observed a synchronous effect of environmental variability in both larvae and juveniles. The ecological groups most associated with the estuarine upper reaches (freshwater, catadromous and residents) were positively correlated with precipitation and river runoff, and negatively relate with salinity, highlighting the key role of local hydrology in structuring fish larval and juvenile assemblages. A similar response was observed for the more generalist feeders (invertebrate and omnivorous). In contrast, marine species were positively influenced by salinity, pointing to the effects of “estuarine marinization” as a consequence of reduced river runoff imposed by droughts. Conversely, the NAO was negatively correlated only with marine larvae and juveniles, highlighting the control exerted at wider scales in the marine environment, particularly on the species with complex life cycles that display ontogenic habitat changes between coastal and estuarine habitats.

Our study suggests how multiple factors interactively shape estuarine larval and juvenile fish communities at temperate latitudes, and that these ecosystems are particularly sensitive to hydroclimatic variability linked to global climate. This has clear implications for ecosystem and fisheries management, as many species here included are commercially exploited.

Keywords

Estuaries, Climate Change, Fish, Hydrology

P3.30

Carbon provenance and coastal connectivity -implications for temperate seagrass carbon sequestration capacity

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Abstract

Seagrass has long been established as a coastal blue carbon habitat with near global presence. Their capacity to accumulate sedimentary organic carbon, poses them as a manageable resource to sequester carbon and reduce greenhouse gas emissions. Seagrasses accumulate carbon two-fold through *in situ* photosynthetic fixation of autochthonous carbon and sedimentation of allochthonous carbon from outside the ecosystem. This study collates an updated global synthesis of $\delta^{13}C$ analyses from seagrass sediments and leaves, enabling its categorisation into climatic regions alongside grouping by seagrass species size. For paired $\delta^{13}C$ seagrass sediment and leaf values there was a consistent difference in $\delta^{13}C$ of seagrass leaf tissue and seagrass sediment ($\Delta\delta^{13}C_{seagrass\text{-}sediment}$ $\overline{x}$ = 7.31‰, SD ± 3.69‰), indicating regular presence of allochthonous carbon. The $\Delta\delta^{13}C_{seagrass\text{-}sediment}$ was significantly influenced by the regional climatic position of the meadow and highest in the temperate regions ($\overline{x}$ = 8.34 SD± 3.44‰). The morphology of the seagrass species inhabiting the meadows had an additive significant influence, with the lowest $\Delta\delta^{13}C_{seagrass\text{-}sediment}$ found in monospecific meadows dominated by large seagrass species (Temperate $\overline{x}$ = 5.76 SD ± 2.70‰; Subtropic $\overline{x}$ = 4.18 SD± 3.57‰; Tropic $\overline{x}$ = 6.30 SD± 3.67‰). This suggests seagrass meadows associated climatic setting and subsequent placement within the coastal landscape influences their affinity for allochthonous carbon deposition, particularly in temperate regions. Large seagrass species' higher ratio of belowground biomass supports the accumulation of autochthonous carbon, however within the Northern temperate region there are a limited number of large seagrass species. This global review of seagrass meadows demonstrates that *placement within the seascape* and a meadow's *seagrass species composition* influences its carbon sequestration capacity; making them necessary forecasters of a meadow's carbon offset potential, particularly in the context of temperate seagrass meadows.

Keywords

Carbon sequestration, Seagrass meadows, Carbon provenance, Coastal connectivity

P3.31

Study of the fauna structure of invertebrates associated with roots of the mangal trees of the cassende community.

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Universidade Agostinho Neto, Angola

Abstract

Mangal is a coastal ecosystem, in transition between terrestrial and marine environments.

Characteristic of tropical and subtropical regions, and known as a nursery for various aquatic organisms. The study of the fauna associated with the mangrove is a complex task due to the wealth of organisms present, and also the great influence that environmental variations have on the organisms that colonize these habitats.

The present work aims to characterize the invertebrate fauna associated with the mangrove roots in Cassende; establishing spatial patterns of macroinvertebrates and relating them to environmental variables, identifying anthropogenic pressures in the mangrove ecosystem and promoting conservation.

For the sampling of the macrofauna, samples of roots and sediments were collected at two points, located inside the tidal channel, point 1, fully immersed, and at point 2 exposed during low tide in a mangrove community established by the method of Braun Blanquet.

Abiotic data such as sea water temperature, dissolved oxygen, pH and salinity were measured using a multiparametric probe. Data analysis was performed using software: R version 3863.2.2, correspondence analysis (AC), PRIMER 6 © v 6.1.6 and the diversity indexes were determined: Specific wealth (S), Shannon-Wiener (H ') , Pielou (J´), Margalef (d) and Simpson (λ).

The mangrove is composed of Rhizophora mangle L., Rhizophora mucronata, Laguncularia racemosa (L.), Avicennia sp. and Avicennia germinans.

A total of 365 individuals from the botanical family were found on these species in three botanical families, three genera and five species. 1365 benthic organisms belonging to Mollusca, Cnidaria, Echinodermata, Chordata, Annelida and Artrophoda were identified.

The occurrence of the associated fauna was higher at point 1 on the sub-coast, compared to point 2 on the supralittoral.

Keywords

Mangal, Associated fauna, Macrofauna, Cassende

P3.32

Seagrass

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Abstract

Phanerogamic grasslands are common in tropical regions and are made up of several species adapted to marine environments where they perform important ecological functions and services. Therefore, these species are important sources of energy, stabilize sediments through the rhizome system, provide protection and habitat for the benthic macrofauna and even constitute biotic nursery for several species of ecological and commercial importance.

Despite the important functions, there is a growing decline in these ecosystems, with anthropogenic action being the main driver of degradation. Until the 2000s, only one species of seagrass was described for Africa, however, more recent studies carried out in Cape Verde and São Tomé and Príncipe until 2017, signal the existence of seagrass meadows. Regarding the coastal coast of Angola, studies on seagrass are incipient, re-emphasizing the need to use greater effort in the study of these plants. The present study aims to characterize the grasslands of Halodule wrightii in Laguna do Mussulo, seeking to describe the patches of herbs and associated fauna.

Sampling was carried out between September and November 2019, according to a stratified random strategy, at two stations designated Estacao 1 (South) and Estacao 2 (Center). In each station, a sample and three replicates were used to identify taxonomic groups, determine vegetation cover and sediment granulometry. The results indicated a variation in the composition of H.wrightii biomass between the samples and with temporal influence. Acanthophora sp. was registered with the most abundant seaweed species of H. wrightii. The associated invertebrate fauna was represented by Bivalve Crustaceans and Gastropods

Keywords

Grasslands, Halodule wrightii, Lagoons, associated organisms

P3.33

Carbon sequestration and floral composition in degraded mangrove ecosystems

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Mulawarman University, Indonesia

Abstract

Mangrove forest habitats, including degraded mangrove areas, serve as a carbon absorbent and sink, decreasing carbon dioxide concentration in the atmosphere. This study was carried out in the Kayan Sembakung Delta in North Kalimantan, Indonesia, on a variety of mangrove ecosystem disturbances. This study aimed to estimate carbon sequestration and species composition in degraded mangrove ecosystems. Through each site, a 125-meter transect and a quadrant divided into six plots were used to determine carbon sequestration. These measurements were taken on both live and dead vegetation from either the felling method. The diameter of the tree at breast height (1.3 m) was measured on each tree diameter >5 cm in a radius of 7 m to estimate the above-ground biomass. The diversity index has been used to calculate the species composition and diversity of the vegetation by integrating the dominance index, diversity index, and vegetation similarity index. For each species, different allometric equations have been used to calculate the above-ground carbon stock. Mangrove ecosystems have a high potential to mitigate carbon per unit area, with a carbon stock of 11.60-123.54 Mg C ha-1, according to the results. Through each study site, the vegetation analysis had a high dominance index value (0.70–0.82) but was inversely proportional to the diversity index (0.40-0.58) and similarity index values (0.30-0.41). Moreover, due to the difference in floral composition of degraded mangrove ecosystems, there is a variation in carbon dioxide sequester.

Keywords

Mangrove ecosystem, Kayan-Sembakung Delta, carbon sequestration, degraded forest

PL.01

Memories of working with Victor de Jonge

Karel Essink

Rijkswaterstaat/RIKZ (Retired), The Netherlands

Abstract

Tribute

PL.02

Potential impacts of groundwater-borne nutrients on coastal areas in changing human activities and climate

M. Saito

Okayama University, Japan

Abstract

Although submarine groundwater discharge (SGD) is reported as a minor component in the global water balance compared with large rivers, it is now recognized as an important geochemical pathway (e.g., nutrients) to coastal seas. Many previous studies have revealed that nutrients transported by SGD can support primary production in coastal ecosystems. Conversely, excess nutrient loadings by SGD may cause eutrophication and algal blooms in coastal seas.

In this presentation, potential impacts of groundwater-borne nutrients on coastal areas for both positive and negative aspects, and how these impacts vary with human activities and climate change will be illustrated.

PL.03

Estuarine ecosystems in semi-arid regions: what are the drivers of their high variability and resilience?

U.M. Scharler

University of KwaZulu-Natal, Durban, South Africa

Abstract

Estuaries in regions with low rainfall face a few distinct challenges: runoff is low, catchments may be small, and freshwater abstractions for human activities are high relative to availability. Therefore, estuaries are prone to close during dry seasons for various amounts of time, and meteorological droughts may have severe effects. Amidst sometimes dramatic changes in the abiotic environment, the water quality and biota in such estuaries vary both as a result of the natural climate variability and human activities, but the ecosystems as a whole remain resilient and highly productive. This talk summarises the water quality and biotic response of subtropical estuaries along the South African coastline, where the majority of estuaries are naturally closed off from the sea during the dry season. Both permanently and intermittently open estuaries are considered, and their responses contrasted for drivers for certain changes in their catchment. Different types of estuaries often show opposite responses, depending on morphology and catchment activities. The analysis takes into account water quality parameters as well as biotic community and ecosystem level responses. We observe a distinct response from various water quality parameters (including estuarine salinity, temperature and dissolved oxygen concentration) defining different ecological niches to drivers related to catchment processes, and from biotic communities and individual population. Ecosystem models reveal levels of resilience amidst sometimes extreme driver variability, and ecosystem level indicators reflect the estuarine variability for water quality and community changes.

PL.04

Fish in estuaries and the effects of climate change

A. Franco

Independent Estuarine and Marine Ecological Consultant, UK

Abstract

Estuaries are highly variable environments characterised by short term fluctuations and local gradients of their physical, chemical and geomorphological characteristics. Fish communities in estuaries reflect species tolerances and adaptations to this variability, encompassing a variety of functional groups resulting in different uses of the habitat, from estuarine resident species to opportunistic, transient or straggler species from the adjacent marine and freshwater environments. Fish communities are subject to natural variability within and between estuaries in response to the local environment (gradients and habitat heterogeneity) and to wider-scale factors (e.g. estuary size and latitude). Anthropogenic pressures also affect the characteristic and distribution of fish communities in estuaries, with pressures exerted both at the local level (e.g. habitat loss, pollution) or originating outside of the estuary (e.g. climate change). Fish generally experience climate through temperature, winds, currents and precipitations, with additional climate effects on fish populations in estuaries also arising from alterations of habitat availability and suitability consequent to changes in the hydrological regime, saline intrusion, and water quality. This paper will explore available evidence of changes to community characteristics and distribution of fish in estuaries and whether these can be attributed to climate change. Given the connectivity between estuaries and the coastal marine environment, the paper will also explore the routes through which changes in estuarine fish communities may affect marine resources and their exploitation (e.g. fish stocks and fisheries).

PL.05

The fate of mangrove forests in the Anthropocene

D. Friess

National University of Singapore, Singapore

Abstract

Mangrove forests are a dynamic intertidal ecosystem, and millions of people rely on the ecosystem services they provide. However, mangroves have experienced rapid changes in their extent due to the extraction of those ecosystem services alongside large-scale land use change. As such, mangroves are a key ecosystem with which to study human-environment interactions in the past, present and future. This talk will assess the broad state of the world's mangrove forests, highlighting key challenges and opportunities to mangrove conservation. Mangroves were considered one of the world's most threatened ecosystems in the 20th Century, though deforestation has slowed since the turn of the 21st Century. However, hotspots of mangrove loss still remain in countries such as Myanmar and Malaysia, and new proximate drivers of deforestation, such as oil palm, are emerging. Sea-level rise may also threaten many of the world's mangroves, though networks are beginning to estimate the future resilience of mangroves in previously under-researched regions. Mangroves are now a global conservation and restoration priority and there is increasing conservation optimism, though several management challenges must be overcome in order to secure the long term future of the world's mangrove forests.

PL.06

Habitat restoration, flood risk and human nature: is managed realignment what we need for the coasts and estuaries we want?

Luciana Esteves

Bournemouth University, UK

Abstract

Habitat loss, growing population and rising sea levels – these are realities along many coasts and estuaries worldwide. These pressures are shifting people's attitudes and governments' actions. Managed realignment (MR) is an example; a shift from traditional flooding and erosion risk management to nature-based solutions. MR is an umbrella term to describe a range of schemes that aim to obtain environmental and socioeconomic benefits, most commonly by artificially restoring tidal flow into embanked land.

Over 140 MR have been implemented across Europe since the 1980s, with increasing number and size of projects in the 21st century. Our knowledge about MR is still limited. We must ensure that realigned coasts are a better legacy to next generations than the one left by centuries of inadequate hard engineering and human occupation. To do so, we need to embrace the opportunities that MR presents for research development (and societal impact) covering hydrodynamics, cultural heritage, ecological functions, law, geomorphology and public health, to name a few.

In setting this conference theme, the conveners have stated: "*The challenge is to harness these opportunities through new ways of thinking, scientific developments, innovative technology and more effective integration of science and management*." This is the exact focus of this talk. Using examples from around the world, the talk will summarise what the implementation of MR has achieved so far. Then, we will consider whether progress is happening at the pace required to realise the estuaries and coasts we want in the future. Do we have a common vision for our coastlines? Are we producing the science and the scientists able to transform the way we produce, communicate and apply knowledge for the future of our coastlines? Having set the grounds for debate, the talk will then discuss examples of opportunities that these exceptional challenges present to the scientific community.

Keywords

adaptation, nature-based solutions, managed realignment, knowledge

PL.07

Bio-physical interactions can shape populations

J. Schlaefer

James Cook University, Australia

Abstract

Bio-physical interactions can shape the structures and dynamics of populations. Open populations are well mixed over hundreds to thousands of kilometres. In contrast, closed populations exchange few individuals through immigration and emigration. The closure of marine and estuarine populations at surprisingly small spatial scales is increasingly being reported. Interactive biological and physical mechanisms determine the spatial scales of population closure. Examples of biological mechanisms include animal behaviour and pelagic larval duration, while physical mechanisms include large and small-scale currents and tides. Multidisciplinary studies are often required to determine the causal mechanisms of population closure. In this presentation I will discuss the results of multidisciplinary studies that have utilized genetic analyses, laboratory and field experiments, and/or biophysical modelling to elucidate the spatial scales separating closed populations, and to identify the factors isolating the populations. I will largely focus on marine and estuarine jellyfish populations.

PL.08

The ‘Paradox of Chaos’ in stable environment: new insights into ecological theory

H.R. Schubert, I.V. Telesh, S.O. Skarlato

University of Rostock, Germany

Abstract

Despite the enticing discoveries of chaos in nature, triggers and drivers of this phenomenon remain a classical enigma which needs irrefutable empirical evidence. By starting with the results of a yearlong replicated mesocosm experiment with plankton community, which revealed signs of chaos at different trophic levels in the artificially maintained stable abiotic environment, the presentation critically reviews temporal and spatial aspects of unpredictability in ecology.

In the mesocosm experiment, chaos was registered as episodes that vanished unpredictably or were substituted by complex behaviour of other candidates when longer time series were considered. In mesocosms without external stressors, we observed the ‘Paradox of Chaos’ when biotic interactions (internal drivers) were acting as generators of internal abiotic triggers of complex plankton dynamics. A critical evaluation of robustness of the Lyapunov-exponent calculations by applying the originally developed Integral Chaos Indicator for quality assessment revealed a number of false-positive as well as not sufficiently supported episodes. Still a number of episodes with unpredictable behaviour remained valid, suggesting that biotic interactions may generate chaotic plankton dynamics in the absence of strong external forcing. Surprisingly, the mechanisms provoking chaotic plankton behaviour seemed to be internal abiotic interactions by nature – in the recent example, energy limitation (both ways – primary one by irradiance as well as secondary by shortage of food resources) and pH fluctuations were the most conspicuous candidates.

This presentation finally will highlight the importance of quality assessment of Lyapunov-exponent calculations and discuss the problem of scale for evaluation of stability as well as predictability of ecosystem dynamics, the latter aspect becoming increasingly important for environmental management and nature protection practices.

PL.09

The merging of traditional knowledge, science and policy to support conservation and management: a case study from Palau

Y. Golbuu

Palau International Coral Reef Center, Palau

Abstract

For Palauans to have survived 1000 years on their small islands, they had to develop systems of management and conservation that allowed them to face environmental challenges as well as resource extraction. Traditional management and practices were put in place, such as the “bul”, which bans harvesting of resources at certain times and places, typically on fisheries species. These cultural actions are still in practice today, but have been adapted to meet changing conditions and stressors, as well as to integrate new scientific knowledge. Traditional Palauan management practices have always been based on meeting the needs of both present and future generations, with a willingness to sacrifice today for the benefits that will be accrued tomorrow. Such is the underlying value of traditional conservation ethics that Palau applies through modern conservation and management efforts such as fisheries protection, a protected areas network establish on land and at sea, the Palau National Marine Sanctuary that fully protects 80% of the EEZ, along with strict control of waste including active recycling of glass, plastics and cans, and integrated land-use management.

PL.10

How can we build a sustainable Blue Economy?

Valerie Cummins

University College Cork, Cork, Ireland

Abstract

TBC

WC.1

Welcome Address

Mike Elliott[1], Tim Jennerjahn[2], Motoyuki Suzuki[3]

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Abstract

Welcome

WC.2

ECSA and EMECS introduction and background

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Abstract

Introduction & Background