Bund für Umwelt und Naturschutz Deutschland
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APOC
Anthropogenic impacts on particulate organic carbon cycling in the North Sea

The seafloor, a climate miracle

Newsletter on cutting-edge research and policy developments

ISSUE 1 • JUNE 2022

Welcome to the first newsletter of the project "Anthropogenic impacts on particulate organic carbon cycling in the North Sea" – APOC for short. Twice a year, this newsletter will accompany our research and project activities, highlight the latest scientific findings and summarise current developments in the field of marine environmental policies. Overarching topics are the function of the North Sea as a natural CO_2 sink and the influence of human activities on its effectiveness to sequester and store carbon.

APOC is an interdisciplinary project funded by the BMBF as part of the MARE:N Coastal, Marine and Polar Research for Sustainability program. It combines the expertise of four marine research institutes and one organisation for environmental conservation. We are investigating the influence of environmental and climatic changes as well as anthropogenic pressures on the transport, circulation and storage of particulate organic carbon (POC) in the North Sea – today, in the past century and in the future.

We hope you enjoy this compilation of our recent activities and current research findings in combination with a political backdrop!

- the APOC team

The CO_2 sink North Sea

The North Sea is one of the most productive marine regions in the world. This makes it an important natural sink for „blue carbon" – a process in which carbon dioxide (CO_2) is extracted from the atmosphere and stored in the sediments at the seafloor. At the same time, the North Sea is one of the most intensively used seas in the world. Its ecosystems are under considerable and increasing pressure from human activities such as fishing, sediment management or the expansion of offshore renewable energies.

ABOVE – Phytoplankton bloom in the North Sea, © NASA Earth Observatory

AWI BUND GEOMAR hereon UHH

News from the APOC project

Follow the current activities, events and progress in our interdisciplinary project – from research cruises in the North Sea to first laboratory results and modelling efforts to joint workshops with project network and cooperation partners.

Kickoff-Workshop

AWI | BUND | GEOMAR | Hereon | UHH

After the official start of the project in April 2021, the first joint meeting of all project partners took place two months later in June. Unfortunately, still in digital from due to the COVID-19 pandemic, but nonetheless with a lot of drive and planning spirit! The eventful day included presentations of all work packages and related work plans, with a special focus on the next milestones.

BUND workshop on the current political context

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A particularly important aspect of the APOC project is the bidirectional exchange between science and politics/society. In order to be able to act in the context of current marine environmental policy, the BUND Marine Conservation Office presented the "state of affairs" of the policy landscape for all project partners. A regular exchange on this topic takes place every six months through the project's internal working group on current marine environmental policy. The first meeting took place in March 2022.

BELOW – Participants of the BUND workshop.

ABOVE – RV Heincke in the port of Helgoland, © AWI.

Research cruises in the German Bight and the Skagerrak

WP1-WP3 | AWI | GEOMAR | Hereon

In order to understand the local deposition, resuspension and remineralisation processes as well as the lateral transport of organic carbon in the North Sea, scientific cruises on research vessels are an indispensable tool. Within the framework of APOC, these will lead in particular to the hotspots for carbon deposition in the project area – the Helgoland mud area and the Skagerrak. The focus of these research cruises lies on sediment and pore water sampling, the measurement of suspension and transport rates as well as benthic fluxes.

Overview of research cruises with APOC participation (incl. partner projects):

- Alkor AL557 | Map | Report 1 | Report 2
- Alkor AL561 | Map | Report
- Heincke HE575 | Map | Report
- Heincke HE581 | Map | Report
- Heincke HE582 | Map | Report
- Heincke HE588 | Map | Report

ABOVE – Observatory in the Helgoland mud area.

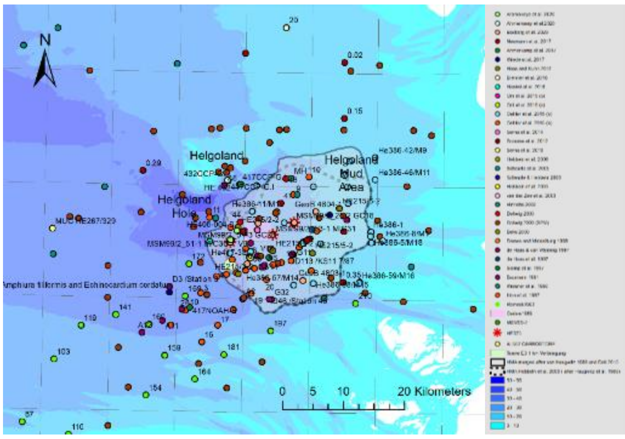
Searching for clues in the Helgoland mud area

WP1 | AWI

During a RV HEINCKE research cruise in August 2021, we successfully deployed a benthic observatory in the Helgoland mud area. It measured hydrodynamic processes near the seafloor as well as the transport of particulate organic carbon (POC) in the study area. At the same time, we determined the amount and reactivity of resuspendable organic material in the upper sediment layer using incubation experiments.

Additionally, and for the first time, we systematically recorded and evaluated available studies in the Helgoland mud area, integrated them into a database and implemented it in a Geographical Information System (GIS).

BELOW – GIS map with locations of previous studies in the Helgoland mud area.



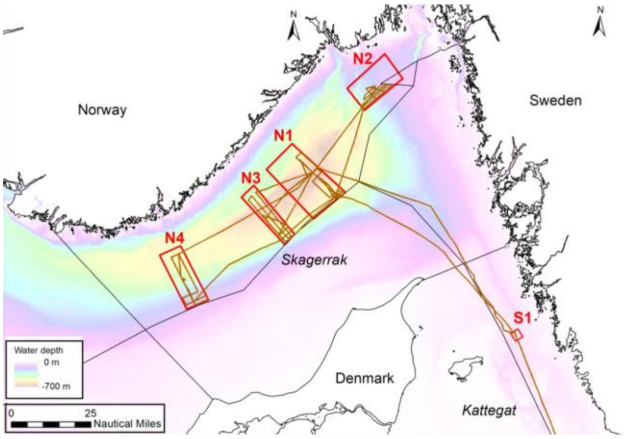
The Skagerrak – rich in organic carbon

WP1 | GEOMAR

Another important research cruise took place in August 2021, this time on the RV ALKOR. This campaign allowed us to sample sediments from the Skagerrak, one of the most effective depositional areas in the North Sea. Here, sedimentation rates of up to 1 cm/year are known, with a high particulate organic carbon (POC) content of up to 3%. We will be using a wide range of analytical techniques to determine how the origin and reactivity of POC, sedimentation conditions and biogeochemical processes control the mineralisation and embedding of POC. And how these processes have changed over the past 100-200 years. For this purpose, we will investigate samples from the water column as well as the bottom water with the following objectives:

- Development of an age-depth model to determine local sedimentation rates
- Differentiation between locally produced and laterally transported organic carbon
- Characterisation of potential sources of sediments in the North Sea and Baltic Sea (analysis of their origin)
- Reconstruction of the POC input from the North Sea into the Skagerrak

BELOW – Working areas of the RV ALKOR research cruise AL561 to the Skagerrak in August 2021.



Human activities in focus – the impact of fisheries on the seabed

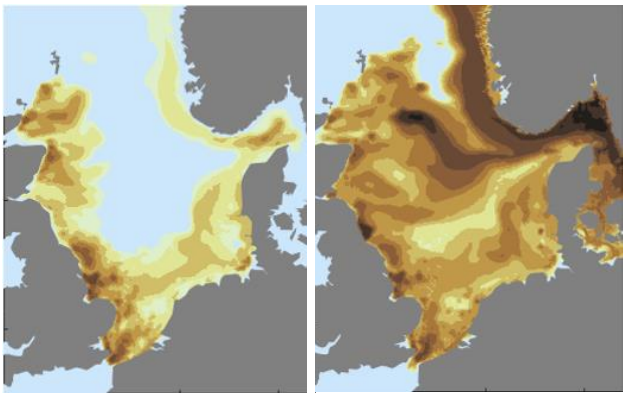
WP 2/3 | Hereon

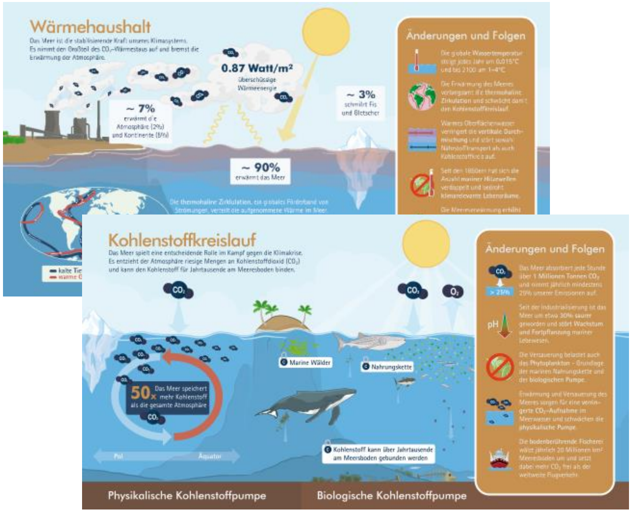
Mobile bottom-contacting fisheries are among those human activities that have a particularly large impact on natural marine ecosystems. Not only does it provide a major source of physical disturbance to the habitats and alters geochemical processes, it also stirs up sediment from the seabed and brings it back into the water column. We investigated this trawling-induced seabed resuspension in a 3D coupled ocean and sediment transport model for the North Sea. The parametrization considers the vessel size and gear type as well as the seabed composition.

Initial results suggest that the resuspension of sediments by bottom-contacting gear exceeds that by natural processes many times over. After one year of simulation, the amount of particulate organic carbon reaching the water column through trawling activities is of the same order of magnitude as the expected natural sedimentation. This indicates that bottom trawling has severely limited the North Sea's long-term natural carbon storage capacity in the past – and continues to do so with ongoing trawling activities.

In a next step, we will investigate the effects of changes in fishing pressure (e.g. through local bans on bottom trawling) and how the current plans for a massive expansion of offshore renewables will affect the system.

BELOW – Suspended matter in the water column after one year without (l.) and with bottom trawling (r.).





ABOVE – Illustrations from the BUND series „Sea and Climate" (heat balance, marine carbon cycle).

Knowledge transfer to society

WP 4 | BUND

As part of the APOC subproject „OpenMic", the BUND Marine Conservation Office is involved in the preparation of scientific findings for various stakeholders. In order to sharpen society's view of the climate-relevant properties of the sea and to stimulate discourse on its natural carbon sink function, the thematic series "Sea and Climate" was launched. It includes a dedicated webseite (German only), topic-specific illustrations and an accompanying factsheet series that regularly examines various subtopics. The first two issues of the series take a closer look at ocean heating, the marine carbon cycle and the role of fish.

BELOW – Excerpt from the first BUND factsheet "The blue climate miracle in crisis".

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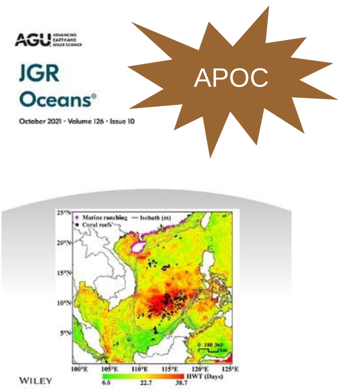
DAS BLAUE KLIMAWUNDER IN DER KRISE

BUND FAKTENCHECK-REIHE „MEER & KLIMA" – TEIL 1

Das Meer ist der zentrale Taktgeber für unser Klima. Und gleichzeitig unser größter Verbündeter in der menschengemachten Klimakrise. Es entzieht der Atmosphäre riesige Mengen an Kohlenstoffdioxid (CO_2) und nimmt den Löwenanteil des durch den Treibhauseffekt entstehenden Wärmestaus auf. Ein wahres Wunderwerk, das den globalen Klimawandel abschwächt.

In brief – current research highlights

In this section, we spotlight selected literature with high relevance around the APOC-specific topics of the marine carbon cycle and human activities. In addition to our own research, this also includes external results from peer-reviewed studies and reports.



Quantifying Importance of Macrobenthos for Benthic-Pelagic Coupling in a Temperate Coastal Shelf Sea

Zhang et al. (2021) | J. Geophys. Res. Oceans | DOI: 10.1029/2020JC016995

The study quantifies the driving mechanisms behind the distinct annual cycle of benthic oxygen fluxes in the German Bight. A novel 3D benthic-pelagic coupled model reconstructs benthic states considering the interactions among macrobenthos, bioturbation, oxygen consumption and early carbon diagenesis. Bioturbation is found to contribute up to 87% ± 4% of the total benthic oxygen fluxes in muddy seabed.

Quantifying the resuspension of nutrients and sediment by demersal trawling

Breimann et al. (2022) | Cont. Shelf Res. | DOI: 10.1016/j.csr.2021.104628

The specifications of different net types used in mobile bottom trawling have a strong influence on the amount of dissolved and particulate material brought into suspension. The study quantifies, for different net types, the influence of resistance and pressure on the amount and concentration of suspended sediments and nutrients.

Estimating global biomass and biogeochemical cycling of marine fish with and without fishing

Bianchi et al. (2021) | Science Advances | DOI: 10.1126/sciadv.abd7554

The study presents a first estimate of the historical decline in global fish biomass due to fishing activities. Before their exploitation, fish contributed to about 2% of global primary production and 10% of deep biological carbon storage. By the 1990s, these figures had already halved.

Physical Disturbance by Bottom Trawling Suspends Particulate Matter and Alters Biogeochemical Processes on and Near the Seafloor

Bradshaw et al. (2021) | Front. Mar. Sci. | DOI: 10.3389/fmars.2021.683331

Quantitative investigation of physical and biogeochemical impacts of mobile bottom trawling. Even a small commercial trawler (12x4 m) with a 36 m-wide otter trawl track can displace about 1,000 m^3 (500 t) of sediment per km of track and bring nearly 10 t of sediment into suspension.

EU request on how management scenarios to reduce mobile bottom fishing disturbance on seafloor habitats affect fisheries landing value

ICES Advice (2021) | DOI: 10.17895/ices.advice.8191

The International Council for the Exploration of the Sea (ICES) examined five management scenarios to reduce the pressure and impact of bottom trawling on the seabed in EU waters. Accordingly, a reduction in fishing effort of just 10% would increase the trawl-free marine area to more than 40%.

Offshore Wind Farm Footprint on Organic and Mineral Particle Flux to the Bottom

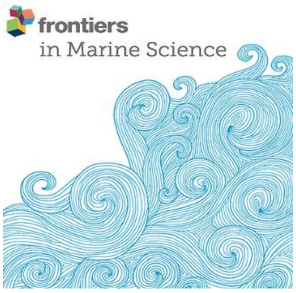
Ivanov et al. (2021) | Front. Mar. Sci. | DOI: 10.3389/fmars.2021.631799

The construction of offshore wind farms leads to strong changes in the deposition of organic material on the seabed – both inside and outside of wind farms. The modelling study concluded that within a radius of 5 km around the turbines, the carbon balance is positive (more organic material), while deposition is significantly reduced within a radius of up to 30 km.

Integral functions of marine vertebrates in the ocean carbon cycle and climate change mitigation

Martin et al. (2021) | One Earth | DOI: 10.1016/j.oneear.2021.04.019

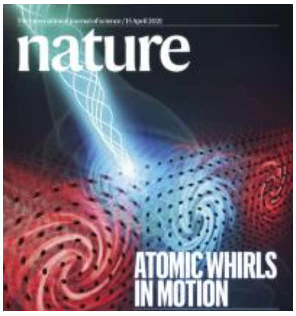
A review of current knowledge on the interaction between marine vertebrates and the marine carbon and nutrient cycles. The review highlights that consideration of these integral functions of marine vertebrates is essential in policy plans to mitigate climate change.



Carbon on the Northwest European Shelf: Contemporary Budget and Future Influences

Legge et al. (2020) | Front. Mar. Sci. | DOI: 10.3389/fmars.2020.00143

A compilation of scientific research results on the carbon budget of the Northwest European continental shelf seas including coastal, pelagic and benthic carbon stocks and fluxes. The work also looks at future impacts of climate change and human activities on these stocks and fluxes.



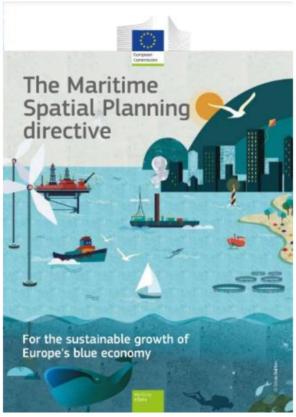
Protecting the global ocean for biodiversity, food and climate

Sala et al. (2021) | Nature | DOI: 10.1038/s41586-021-03371-z

Widely noticed study that introduces a conservation planning framework to help prioritise highly protected marine areas. Among other things, it presents a first estimate of the amount of carbon released from the seabed by mobile bottom trawling. The hypothesis that this could be on par with the annual CO_2 emissions of the global aviation sector have been and continue to be discussed controversially.

The transition of marine environmental policy

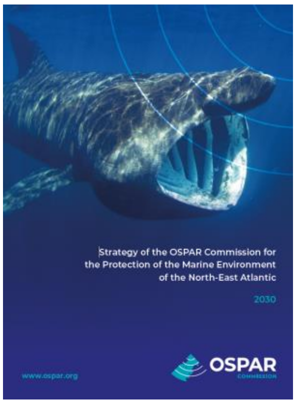
How does the political framework in the North Sea change? What influence does this have on marine anthropogenic pressures and the state of marine carbon sinks? This section summarises important events at national, regional and international level.



EU Maritime Spatial Planning (MSP) Directive

MSP Directive | EU MSP-platform | eMSP: EU-financed MSP-Projekt

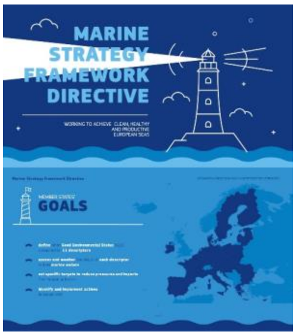
All 22 coastal member states have been obliged under the MSP Directive to develop a national maritime spatial plan by 31 March 2021 at the latest. The directive intends to help manage the balancing act between increasing demand for marine space from traditional (e.g., fisheries) and emerging sectors (e.g., renewable energies) on the one and the preservation of marine ecosystems on the other hand. The plans are subject to a review period of at least ten years. The respective member states are free to shape the form and content of their maritime spatial plans – including institutional arrangements and the allocation of maritime activities.



OSPAR Environmental Strategy for the North-East-Atlantic (incl. North Sea)

North-East Atlantic Environment Strategy (NEAES) 2030 | Further information

On 1 October 2021, the new environmental strategy of the OSPAR Commission was adopted by the contracting states. It includes, among other things, the restoration of degraded benthic habitats (target 6) and the mitigation of climate change and ocean acidification through the protection of the marine environment as a natural carbon sink (target 12). The strategy was accompanied by a review of previous objectives. Additionally, an implementation plan sets out specific actions and tasks to achieve the new targets and will be used to record and evaluate progress in implementing the strategy.



Review of the Marine Strategy Framework Directive (MSFD)

MSFD Directive | EU report on the implementation of the MSFD

In 2008, the EU adopted the MSFD with the ambitious goal of achieving a "good environmental status" of the seas by 2020. The goal was to create and maintain healthy, productive and resilient marine ecosystems, while ensuring sustainable use of marine resources. In April 2021, the European Commission launched an evaluation of the Directive to review and assess its effectiveness, efficiency, relevance and coherence with other policies by 2023. This evaluation also includes a series of public consultations.

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