OUTFLOW

Quantifying the cOntribUTion of Fouling fauna to the Local carbon budget of an Offshore Wind farm

DURATION
15/01/2021 - 15/04/2025

BUDGET
624 237 €

PROJECT DESCRIPTION

CONTEXT

This project is rooted in the society's desire to combat climate change by reducing emissions of CO_2. This can be done by using renewable energy sources, one of them being wind. As wind energy developments require considerable space and wind, they are often located in open, windy landscapes, which are widely available at sea, leading to a proliferation of offshore wind farms (OWFs). In 2019, 5047 offshore wind turbines in 110 OWFs across 12 European countries represented a capacity of 22.07 GW This is expected to rise to 70 GW in 2030 to produce 30% of the EU's power demand.
While most OWFs are currently located in Europe, they are also advancing along the US Atlantic coast and in several areas in Asia and South-America. Installation of OWFs generally comes with a loss of the original soft-sediment habitat and addition of artificial hard substrate (turbine foundation and surrounding scour protection). Information on the effects of this habitat modification is mainly generated through local monitoring programmes which generally assess structural changes in biota and the environment. The new artificial hard substrates are rapidly colonised by large densities of fouling fauna, the majority of them (in terms of species, density and biomass) being suspension feeders. However, apart from scattered information on increased local production of certain fish species and large crustaceans, and increased knowledge on OWF food-web structure, there is a very limited understanding of the functional consequences of the strong concentration of suspension feeders within OWFs for the marine environment.
At the same time, in the immediate vicinity of turbines, strong changes in sediment characteristics and fauna have been These changes encompass a fining of the sediment, with an increase in the fraction of fine sediment (125-250 µm) and in OM content, increased benthic anoxia in otherwise well-aerated sediment, and a shift in macrofaunal communities towards communities that are usually encountered in low-energy environments.

GENERAL OBJECTIVES

The general objective of OUTFLOW is to test the hypothesis that the faecal pellet production by fouling fauna plays an important role in the local organic matter (OM) dynamics and sequestration within OWFs by estimating its contribution to the pelagic and benthic OM pool. This overarching objective will be reached through 6 sub-objectives: (1) develop tracers for faecal pellets; (2) estimate the contribution of faecal pellets to the pelagic and sedimentary OM pool in offshore wind farms; (3) model the spatial dimensions of faecal pellets enrichment of sediments; (4) determine the fate of faecal pellets in the sediment; (5) estimate the Blue Carbon sequestration potential of altered OWF sediments, and (6) investigate the effect of offshore wind farms on OM dynamics at a larger geographical scale. Objectives 1, 2 and 4 will provide insight in the dynamics of the OM processing in offshore wind farms, while objectives 3, 5 and 6 will yield insights in the spatial 'heterogenisation' of OM-flow patterns at the local and wider geographic scale.

METHODOLOGY

OUTFLOW is based on five scientific work packages (WP 1-5), supported by three administrative work packages (WP 6-8). The scientific work packages involve an integration of experimental, field and laboratory work, and ecological and oceanographic modelling across the marine water column and sediment domains. Work Package 1 focuses on the development of analytical protocols for stable isotope fingerprinting of amino acids (AA) and the design of a dedicated suspended particulate matter (SPM) trap. These newly developed analytical protocols and the SPM trap will be used in WP 2, where intensive sampling events will result in detailed information on the stable isotope signature of the AA in the bulk OM pool in water and sediment, and the individual contributors (phytoplankton, size-fractionated zooplankton, faecal pellets). We will use multiple metrics to characterise FPs and other contributors to the marine OM pool and estimate their contribution to the total OM pool in water and sediments.

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Modeling efforts will result in an upscaling of the detailed local measurements around a single wind turbine to the scale of an offshore wind farm (WP3). Detailed biogeochemical measurements, and a pulse-chase experiment will provide knowledge on the fate of the faecal pellets after their deposition to the sediment. We will investigate mineralization processes, carbon burial and the benthic food web through detailed measurements and lab-based experiments. We will couple the detailed biological and biogeochemical measurements with oceanographic models for an upscaling towards the scale of the Southern North Sea, taking into account the presence of multiple wind farms. Inaddition our approach will assist in assessing the effects of different decommissioning scenarios at a wider geographical scale.

IMPACT OF RESEARCH

OUTFLOW will have a major impact on *scientific knowledge* by developing OM tracers, to be tested and applied to faecal pellets (FP) in an offshore wind farm (OWF) assessment context. Because such tracers are not available as yet, these results are expected to have an eminent impact on organic matter (OM) characterisation also beyond the study of OWFs.
Apart from the methodological advancements, OUTFLOW will be the first to provide a data-driven assessment of the effect of multiple OWFs on the carbon flow in a (sub)regional sea, and will as such shed a light onto the so-called “patchinisation” of the carbon flow as a consequence of ocean sprawl.
OUTFLOW’s impact on *economy, policy and public services* and *environment and health* will be substantial as it links all aspects in an evidence-based manner. Marine spatial planning is thé tool aiming for allowing for Blue Growth while maintaining and restoring ecosystem health. Marine spatial planning however needs to be based on sound scientific knowledge, valid for larger geographical scales and accounting for a cumulation of local effects. Our results can be used to run scenarios, where the local and regional effect of alternative locations of OWFs can be investigated, thereby providing a powerful marine spatial planning tool for the *sustainable management of Blue Growth scenarios*.
At the same time, the debate about *decommissioning* OWFs is in full swing. In the OSPAR region (NE Atlantic), offshore constructions need to be fully removed after their exploitation phase (for OWFs: 20-30 years), with e.g. the seabed to be restored to its original state. Derogations however are possible yet demand the science needed to objectively assess decommissioning scenarios. Biodiversity and connectivity but also carbon flow (as part of ecosystem functioning) are the key foci here (see https://www.insitenorthsea.org). OUTFLOW will be of direct use to assess the effects of different decommissioning scenarios on the (sub)regional OM pool in the water column and sediment, the extent of heterogenisation (or “patchinisation”) of OM, and ultimately the capacity of the sediment to store carbon. To the best of our knowledge, there is no other decision support tool in the pipeline that can provide such OM-focused guidance on how to best deal with decommissioning.

EXPECTED FINAL RESULTS

- Detailed isotopic fingerprinting protocols
- Isotopic markers for marine organic matter end members
- Suspended Particulate Matter trap for dedicated deployment in offshore wind farms
- Quantitative assessment of the Blue Carbon potential of offshore wind farm sediments
- Modeling tools (updated versions of the biological module of COHERENS) to assess the effects of multiple wind farms on the scale of the Southern North Sea
- Mapping tool to assess the effects of additional offshore wind farms and/or decommissioning scenario’s on the redistribution of organic matter at the Southern North Sea scale.

CONTACT INFORMATION

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LINKS

www.researchgate.net/project/OUTFLOW