Student Research Projects

NIOZ Marine Masters Summer Course 'Exploring the Wadden Sea'
NIOZ Royal Netherlands Institute for Sea Research, Texel, 9 July - 21 July 2023

Project 1: Tidal dynamics of the Marsdiep

The Wadden Sea is a complex tidal ecosystem, changing continuously in terms of currents, waves, sea level, temperature, salinity, sediment concentration and hence light conditions and availability of nutrients. This dynamic environment drives the biodiversity and productivity of the lower parts of the food chain (phytoplankton and zooplankton). In this project we will use temperature and salinity observations, as well as recorded velocities, over the entire depth of the field site to characterize the water flowing through the Marsdiep during one complete tidal cycle. Analysis will reveal whether there are differences in water masses and whether there is net in or outflow through the inlet. Biotic and abiotic consequences of the observed hydrodynamic conditions can then be derived. For this project, programming experience is required (preferably Matlab or Python).

Project 2: The effect of nutrient balance and zooplankton grazing on phytoplankton dynamics

In the marine system, the phytoplankton component supports the whole trophic network by producing organic matter via photosynthesis. Physical, chemical and biological factors can alter the phytoplankton biomass, community structure and primary production, with consequences across the whole ecosystem. The Wadden Sea is strongly influenced by humans, and the introduction of excess nutrients has led to eutrophication (enrichment) which could lead to the environmental degradation of parts of the Wadden Sea. The management of the water inflow into the Wadden Sea has resulted in an imbalance between nutrients affecting the phytoplankton community. Moreover, phytoplankton is directly controlled by the zooplankton population which grazes on phytoplankton cells and thus affects the structure and biomass of the phytoplankton community as well. In this project, two experiments will be conducted: one considering the impact of nutrient enrichment on the phytoplankton community and the other one illustrating the top-down link between zooplankton and phytoplankton.

Project 3: Tidal dynamics and their effect on sediment transport

Every day, tidal currents move tons of suspended sediment from the North Sea into the Wadden Sea and back again, through the tidal inlets that breach the Wadden Sea island chain. In the Wadden Sea, sheltered by the barrier islands against the force of incoming waves from the North Sea, sediment particles suspended in the seawater settle out on the seabed. With time, sediments accumulate into vast tidal flats emerging during low tide, which are the typical landscape element of the Wadden Sea and an important habitat for marine life. Whether this landscape will remain during future sea level rise and local seabed subsidence depends on the balance of sediment import and export through the tidal inlets. In this project, we will quantify suspended sediment transport in the Texelstroom in relation to the dynamics of the tide.

Project 4: Spatio-Temporal Analysis at the tidal flats De Schorren, Texel from 2018-2022

The Wadden Sea is an internationally recognized ecological treasure along the Dutch, German and Danish coast. It is a shallow region with large tidal flats that serves as a nursery area for fish and a staging area for migrating birds. Primary production and availability of macrozoobenthos are crucial for their food security. The status of these lower levels of the food web is considered indicative of ecosystem functioning. Currently, the most extensive ecological survey is the SIBES-project: an annual campaign sampling all macrozoobenthos and sediment characteristics on a 500m grid. A large part of monitoring depends on the changes that happen over space and time. We would like to understand the spatial and temporal patterns over a region in the northern part of Texel for sediment or macrozoobenthic properties over the years 2015-2022.

Project 5: Using stable isotopes to unravel the Wadden Sea foodweb

The Wadden Sea is the major feeding ground for migratory birds resting in Northwestern Europe, but it also plays an important role for other species like seals, fish and invertebrates, to name a few. In this project, carbon and nitrogen isotope signatures of various Wadden Sea species, reflecting their past diet, will be used to establish the predominant food sources and therewith a basic food web of the Wadden Sea. The high diversity of parasites in the Wadden Sea organisms might potentially affect the stable isotope signatures of their hosts, and therefore the food web structure. Samples of phytoplankton and zooplankton in the water column, benthic algae, macro- and megafauna will be collected from tidal flats and on board the research vessel Navicula. The crabs collected on the RV Navicula by dredging will be analyzed for parasitic infections and comparisons between infected and uninfected crabs will be done. Results will be integrated in the food web analysis.

Project 6: The role of fungi in degradation of hydrocarbon compounds in the marine environment

Fungi possess the remarkable ability to break down a wide range of substances, including complex hydrocarbons like lignin and cellulose, as well as various pollutants such as DDT, polycyclic aromatic hydrocarbons, and even TNT. This exceptional capability is attributed to the diverse set of digestive enzymes that fungi employ, earning them the title of "masters of degradation". However, there is a notable lack of research on fungi in marine environments, particularly regarding their role in breaking down pollutants present in the oceans. The primary goal of this research project is to isolate particular fungi from the Wadden Sea that demonstrate the ability to grow on oil as a substrate. Moreover, we will employ assays to quantify the degradation products generated during the breakdown of oil. Main methodology applied here will be isolation of marine fungi via plating on fungal specific media and using these or already isolated fungal strains to carry out activity assays, where Gas Chromatography Mass Spectrometry (GC-MS) will be used. Through these analyses, we aim to ascertain the fungal isolates' capacity to degrade specific oil compounds and determine the rate at which they convert them into ultimate degradation products.

Project 7: How shelf seas help reduce climate change

Continental shelf seas play an important part in the carbon cycle. Growth of phytoplankton in highly productive shelf sea waters drives CO_2 uptake from the atmosphere, slowing the effect of our greenhouse gas emissions on Earth's climate. In the North Sea, CO_2 uptake is boosted by alkalinity supplied from chemical reactions in the sediments, particularly in shallow areas like the Wadden Sea, and river waters. Elevated alkalinity also mitigates ocean acidification. In this project, we will measure dissolved CO_2, alkalinity and pH in seawater samples that we will collect on a transect from Texel (where the Wadden and North Seas connect) to the IJsselmeer (freshwater endmember for the Wadden Sea) plus water samples from the IJsselmeer itself. From the data, we will determine the balance of alkalinity supply: how much comes from the IJsselmeer and how much from the sediments? This balance is important to determine for future climate projections, as each supply may

respond differently to human pressures and management decisions. We will also calculate how much extra CO_2 is stored as a result and find the effect on seawater pH and carbonate mineral solubility.