How the blue economy changes phytoplankton dynamics in the BPNS: A modelling approach

Stevens Martha[1], Pint Steven[2], De Troch Marleen[3] and Everaert Gert[2]

[1] IMBRsea, Ugent, Smissestraat 43, 2450 Meerhout, Belgium
E-mail: martha.stevens@imbrsea.eu

[2] Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Oostende, Belgium

[3] Marine Biology Research Group, Department of Biology, Ugent, Krijgslaan 281, S8 9000 Gent, Belgium

Marine phytoplankton is the base of marine food webs and is responsible for approximately 50% of global primary production. Additionally, it is an important driver for the biogeochemical cycles of carbon, oxygen, and nutrients. As a result, marine phytoplankton affects the blue economy in a multitude of ways. Because of its biological, societal, and economic importance, a deep understanding of phytoplankton dynamics is crucial. In the North Sea, primary production is mainly limited by nutrients, solar irradiance, and sea surface temperature. Along with these bottom-up limitations, phytoplankton biomass and species composition are controlled by zooplankton grazing. In temperate regions, seasonal variability in these parameters results in an annual cycle. High nutrient availability combined with sufficient solar irradiance in autumn and spring lead to seasonal phytoplankton blooms, followed by a period of increased zooplankton grazing. As a result of continuously changing conditions, phytoplankton biomass varies at a high-resolution spatiotemporal scale. Besides natural variation, anthropogenic activities, ranging from fisheries, to sand extraction and offshore wind farms, can alter the marine environment. A better understanding of the impact blue economy innovations have on the base of the food web could improve management practices and guarantee an informed development of the blue economy. The Belgian part of the North Sea (BPNS) is a suitable study area for understanding how economic activities impact phytoplankton biomass dynamics, particularly at a high-resolution spatiotemporal scale. The area has a wealth of long-term observations with high spatial resolution. In addition, the BPNS has been greatly affected by both climate change and human activities such as land-use changes. These anthropogenic impacts have altered nutrient availability, sea surface temperature, and turbidity which caused shifts in phytoplankton composition, biomass, and seasonality over the past 50 years. These changes in plankton biomass dynamics and thus biogeochemical cycles, impact the marine ecosystem as well as the societal and economic services they provide.

For this thesis project, a nutrient-phytoplankton-zooplankton-detritus (NPZD) model will be used to simulate the potential effects of blue innovations in the BPNS on phytoplankton biomass dynamics. Two case studies, inspired by future plans in the Belgian blue economy, e.g. the development of offshore wind farms and mussel aquaculture, will be simulated. Factors influencing phytoplankton biomass determinants will be inferred from literature and local observations. Using a calibrated NPZD model for these scenario-based analyses, the effect of blue economy developments on phytoplankton dynamics in the BPNS will be quantified. The outcome of this study will provide new insights into the effects of the blue economy on the pelagic ecosystem, supporting future management decisions in the Belgian part of the North Sea.

Keywords
NPZD; Ecosystem Modelling; Offshore Wind; Mussel Aquaculture