HARMFUL ALGAL BLOOM ADAPTATION: INTEGRATING EARTH OBSERVATION WITH OCEAN MODELLING FOR OPERATIONAL MAPPING OF SAFE-TO-HARVEST AREAS OF SHELLFISH

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Abstract: Toxins from harmful algal blooms can contaminate shellfish, threatening both human health and the aquaculture industry. Identifying when and where shellfish are safe to harvest is crucial for reducing revenue losses in aquaculture. Here, we show how Earth Observation (EO), ocean modelling, and in-situ toxin measurements can be combined to generate maps of safe-to-harvest areas and periods. We use the Norkyst-800 ocean model, which assimilates atmospheric and ocean EO to produce daily forecasts of key ocean variables at high spatial resolution along the Norwegian coast. Modelled sea surface temperature, salinity, and water column stratification are combined with long-term observations of diarrhetic and paralytic shellfish toxins to train and validate probabilistic risk models using machine learning. The calibrated models are used to map areas with a low probability (<5%) of toxin contamination in blue mussels. Sea surface temperature delineates the seasonal risk of contamination, indicating when harmful blooms are likely and shellfish are unsafe to harvest (>5%). Sea surface salinity and stratification help pinpoint locations that remain safe, where low salinity or weak stratification might limit harmful blooms. Overall, integrating EO, ocean models, and field observations enables operational risk models that map safe-to-harvest areas and may support decision-making and spatial planning for shellfish aquaculture. Early adopters from the Norwegian shellfish farming industry, and the regulatory agencies (Norwegian Directorate of Fisheries, Institute of Marine Research) have used and assessed these forecasts during 2026.

Key word: Aquaculture, shellfish, algae toxins, forecasting

Action Areas: