EGU26-414 Hidden Hazards in the Central Eastern Arabian Sea: Metabarcoding Reveals Co-occurrence of ASP, PSP, and NSP Vectors in the Coastal Waters of Goa

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Abstract: Harmful Algal Blooms (HABs) represent a growing threat to marine ecosystems, aquaculture, and public health in the Central Eastern Arabian Sea (CEAS). This study utilized 18S rRNA metabarcoding to characterize the absolute abundance and community composition of potentially toxigenic diatoms and dinoflagellates in the coastal waters of Goa. The analysis reveals a distinct and alarming prevalence of multiple genera associated with diverse toxin syndromes. The dataset was dominated by a massive proliferation of the dinoflagellate Karenia (linked to Neurotoxic Shellfish Poisoning and ichthyotoxicity), which reached extreme abundances exceeding 51,000 reads per sample at the most impacted sites. Co-occurring with this bloom, spatially distinct hotspots of Paralytic Shellfish Toxin (PST) producers were identified, specifically Alexandrium and Gymnodinium spp., with Alexandrium counts peaking at over 5,200 reads. Notably, the potent PST producer Alexandrium tamiyavanichii was positively identified, alongside detections of Gymnodinium catenatum. The diatom community also exhibited significant toxicity potential; the Amnesic Shellfish Poisoning (ASP) genus Pseudo-nitzschia displayed high relative abundance (up to ~3,700 reads), including the presence of P. pungens. Furthermore, vectors for Diarrhetic Shellfish Poisoning (DSP), including Dinophysis spp. and Phalacroma rotundatum, and Yessotoxin producers (Lingulodinium polyedra, Gonyaulax spinifera) were ubiquitously present at lower background levels. These findings highlight a complex, multi-risk scenario where ASP, PSP, NSP, and DSP vectors coexist within the same coastal system. The distinct spatial separation observed between peak Karenia, Alexandrium, and Pseudo-nitzschia events suggests that heterogeneous environmental drivers are influencing specific HAB assemblages. This data underscores the critical need for broad-spectrum toxin monitoring beyond single-species surveillance in the region.

Introduction:

Consequences of Algal Blooms

CDC-Algal blooms can harm people, animals, or the environment when they:
Make toxins (poisons), become too dense, use up the oxygen in the water and release harmful gases

Oxygen Depletion
As algae die, their decomposition consumes oxygen, affecting fish and other aquatic life.

Toxin Production
Some algae produce toxins and release them in environment.

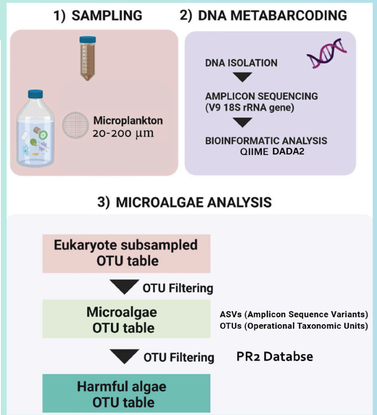
Affecting aquaculture
Mass fish killing, Migration of organisms from habitat

Drinking Water hazard
Deoxygenated and contaminated waters.

Pollution/Recreation Disruption
Scum generation, Polluted smell

Seafood Toxicity
Bioaccumulation of toxins in fish and shellfish can be lethal to animals and humans

Methodology:



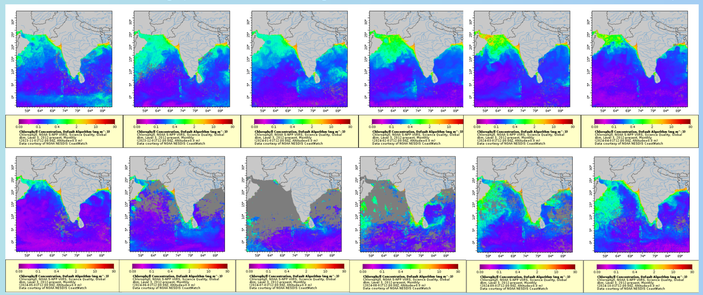


Figure- Monthly satellite-derived chlorophyll-a (Chl-a) concentration in the northern Indian Ocean obtained from the NOAA VIIRS sensor shows Level-3, science-quality monthly composites with 4 km spatial resolution, illustrating the spatial variability of surface chlorophyll concentrations (mg m^{-3}) in the Arabian Sea and surrounding waters during selected months. Warmer colors (yellow-red) indicate higher chlorophyll concentrations associated with enhanced phytoplankton biomass and potential bloom conditions, while cooler colors (blue-purple) represent lower concentrations typical of oligotrophic offshore waters.

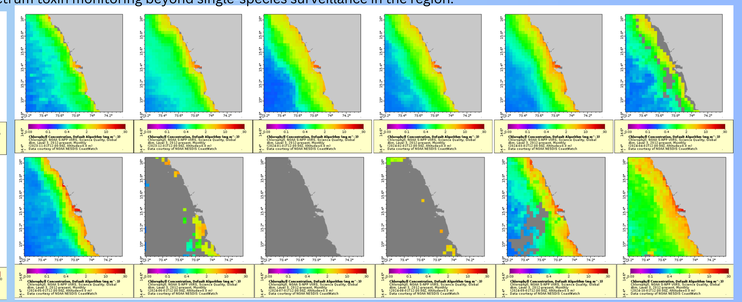


Figure- Satellite derived chlorophyll-a concentration maps for the goan coastal study region along the eastern Arabian Sea extracted from the VIIRS monthly composites. These zoomed in maps highlight the nearshore chlorophyll gradients and localized high concentration patches observed during different months, which are indicative of episodic phytoplankton bloom development in the coastal environment. Grey areas represent land or regions with missing satellite observations due to cloud cover or data gaps.

Results:

Toxic Genus-
Alexandrium, Gymnodinium
Karenia,Dinophysis, Polykrikos
Pseudo-nitzschia, Prorocentrum

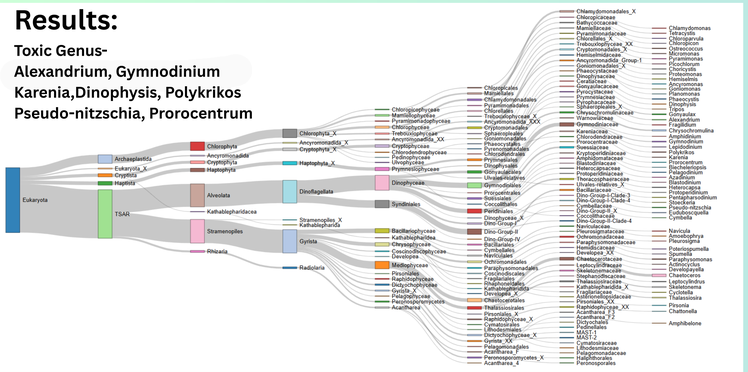


Figure- Sankey plot illustrating the hierarchical taxonomic distribution of reads from domain to genus level.

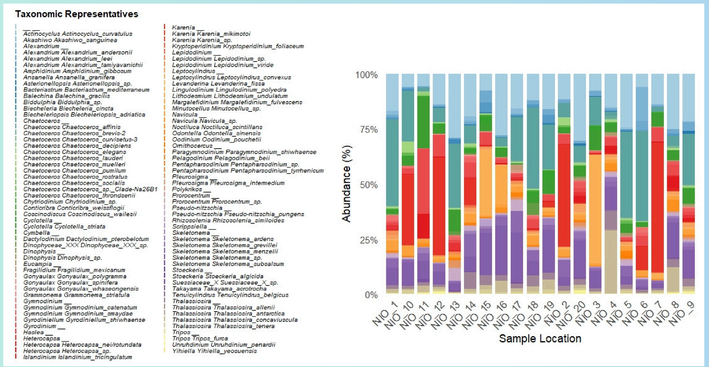
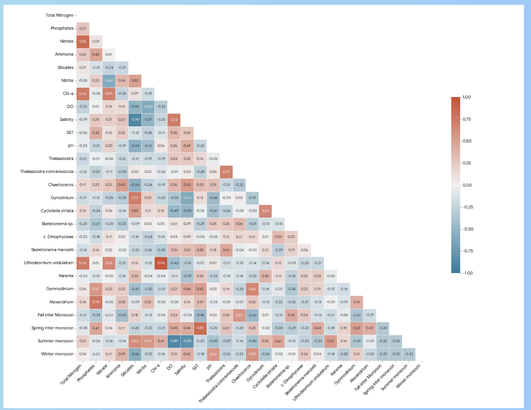


Figure- Percentage relative abundance of major taxonomic representatives across all sampling locations (NIO_1-NIO_20). Each bar represents a station, and colored segments correspond to individual genera/species listed in the taxonomic legend. The y-axis indicates proportional abundance (%), allowing comparison of community composition among stations.



Pearson correlation matrix depicting relationships among environmental parameters, dominant phytoplankton taxa and seasonal categories. Correlation coefficients (r) are shown within each cell, with red indicating positive correlations and blue indicating negative correlations, highlighting nutrient hydrographic control on seasonal phytoplankton community dynamics.

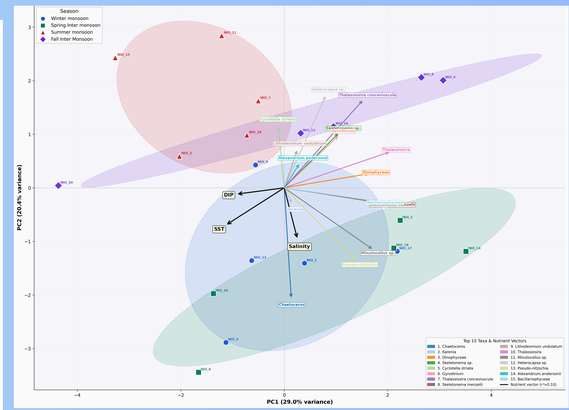


Figure- Principal Component Analysis (PCA) biplot showing seasonal clustering of samples based on phytoplankton community composition and Environment. PC1 and PC2 explain 29.0% and 20.4% of the total variance, respectively. Arrows denote the top 15 contributing taxa (colored vectors), while black vectors represent significant environmental variables ($r^2 \geq 0.10$), including salinity, sea surface temperature (SST), and dissolved inorganic phosphate (DIP). Seasonal separation suggests compositional shifts influenced by hydrographic conditions, with nutrient and salinity gradients contributing to community structuring across monsoonal phases.