International Journal of Advanced Research in Engineering Technology & Science
ISSN: 2349-2819
Email: editor@ijarets.org Volume-8, Issue-2 February - 2021 www.ijarets.org

ALGAL BLOOMS- RECENT ADVANCED

Dr Lakhpat Meena,

Associate Professor. Department of Botany

Shaheed Captain Ripudaman Singh Rajkiya Mahavidyalaya Sawai Madhopur,322001 Rajasthan.

Abstract

Improvements in the detection, prediction, and comprehension of algal blooms have been the primary focus of recent developments in the field of algal bloom research. Machine learning and artificial intelligence have been applied more often in recent years in order to improve the accuracy of forecasts regarding algal blooms. These technologies do an analysis of enormous datasets derived from satellite imaging, in-situ sensors, and environmental factors in order to make more accurate predictions on the presence of blooms. In addition, advanced satellite tools and remote sensing techniques have been created, which have made it possible to improve the monitoring of freshwater and coastal ecosystems and to get a better knowledge of the variables that are contributing to the escalation of hazardous algal blooms.

Keywords: *Algal blooms, advanced, phenomena*

Introduction

Algal blooms, which are frequently brought on by an abundance of nutrients in bodies of water, have the potential to have substantial effects on the environment, the economy, and human health. As a result of recent developments, our capacity to identify, monitor, and anticipate these occurrences has significantly enhanced. The introduction of technologies such as machine learning, artificial intelligence, and improved satellite tools has been of critical importance. These developments make it possible to conduct a more thorough analysis of data derived from a wide variety of sources, which in turn enables more precise forecasting and a more in-depth comprehension of the elements that contribute to algal blooms. This advancement is absolutely necessary in order to lessen the negative impacts that are related with these occurrences. Concerns have been raised all around the world as a result of the growing frequency and severity of algal blooms, which are caused by climate change and activities carried out by humans. Horrific algal blooms, often known as HABs, are capable of producing toxins that have a negative impact on marine life, human health, and local economy. Using cutting-edge technology, recent developments have been made with the intention of addressing these difficulties. Using data from the environment, machine learning systems may make predictions about blooms, which enables preventive steps to be taken. For the purpose of early bloom identification, enhanced satellite remote sensing provides thorough monitoring, which is of great assistance. The implementation of these innovations is essential for reducing the negative impacts and enhancing the management of water quality. In addition, recent studies have concentrated on the effects that algal blooms have on the environment and the economy. Blooms have been proved to have a devastating impact on local fisheries, tourism, and water sources, according to studies. The development of more efficient water treatment methods and the investigation of biological controls, such as the introduction of species that feed on toxic algae, are two of the measures that are being taken to offset the consequences of these factors. Additionally, there is a rising trend of multidisciplinary partnerships, which are bringing together specialists in the fields of marine biology, environmental science, and data analytics in order to develop complete management planning methods. These joint initiatives have the goal of reducing the frequency of algal blooms as well as the intensity of those blooms, so safeguarding ecosystems as well as human interests.

What are algae?

In the same way as plants do, algae are tiny creatures that live in watery settings and make energy from sunlight via a process called photosynthesis—just like plants. Algae may be found in many kinds of natural waterways, including fresh water, salt water, and brackish water, which is a mixture of fresh water and salt water.

Toxins are produced by a select few varieties of algae. It is possible for environmental conditions such as light, temperature, salinity, pH, and nutrient levels to trigger the synthesis of toxins in these algae. Toxins extracted from algae and released into the water or air around them have the potential to cause severe harm to humans, animals, fish, and other components of the environment.

What is a harmful algal bloom?

A hazardous algal bloom, also known as a HAB, is a phenomenon that takes place when toxic algae grow in an excessive amount in a body of water. The excessive development of algae, also known as an algal bloom, is visible to the human eye and can resemble a variety of colors, including green, blue-green, red, or brown, depending on the kind of algae.

There are certain blooms that are simple to identify, while others are more difficult to notice because they grow close to the bottom of bodies of water. Simply glancing at a body of water to determine whether or not it contains a hazardous bloom is not enough.

Algal blooms

The term "harmful algal blooms" (HABs) is used to describe the rapid expansion of phytoplankton species in aquatic habitats, including din flagellates, diatoms, and cyanobacteria (Figure 1). HABs are natural occurrences that, as a result of the creation of toxins or the accumulation of biomass, present significant dangers to human health, the continuation of the environment, and the continued existence of aquatic life. A particular kind of organisms known as dinoflagellates may be accountable for the production of the so-called "red tides" (Figure 1A). There are around ninety marine planktonic microalgae that are capable of producing poisons at the present time. The majority of these microalgae are dinoflagellates, followed by diatoms. Due to the harmful effects that are linked to toxins, poisoning has occurred in humans who have consumed contaminated seafood or in cattle for a considerable amount of time. Shellfish and filter-feeding bivalves have the potential to accumulate toxins, and the ingestion of these shellfish and bivalves by human populations has the potential to cause harm to several systems of the human body, including the neurological system and the digestive system. HABs can also be triggered by non-toxic species that are experiencing significant biomass blooms for a variety of reasons. Because of the shadowing of the benthos and the decrease in oxygen levels that occurs after the bloom dies off, the accumulation of algal biomass may cause the water to become discolored, as well as induce negative consequences and cause a fall in biodiversity. The decomposition of the algae results in low oxygen levels, which in turn have an effect on the plants, animals, and fish that live in the environment (Figure 1C). During the process of respiration, fish may consume water that is high in algae. This water then enters the fish's system, where it causes the generation of reactive oxygen species (ROS), which leads to an increase in oxidative stress and ultimately results in the death of the fish. At the same time, algal cells have the ability to create reactive oxygen species (ROS) as a causal component that leads to the death of fish, which highlights the significant role that oxidizing substances play in bloom toxicity. An further mechanism that may be responsible for the death of fish and other species is the physical damage that is inflicted to the gills by the spines of diatoms. In point of fact, when spinous diatoms cause harm to the gills, the epithelium develops lesions and generates an excessive amount of mucus, which ultimately results in asphyxiation. In spite of the fact that the precise origins of HABs are still unknown, the recent increase in the occurrence of HABs has been attributed to human influences in conjunction with various climatic changes. Both in freshwater and marine ecosystems, HABs have the potential to affect vast or small regions, and the dynamics of these organisms are controlled by a variety of elements, including those that are physical, chemical, and biological. Among them are variations in temperature and nutrients that occur seasonally, as well as stratification in the water column. To be more specific, the stability of the water column is a significant factor in determining the installation of hydraulic anchors. Given the significant interactions that occur between the many processes that contribute to the development of HABs, it is abundantly obvious that a multidisciplinary approach and research that involve several disciplines are essential in order to get a comprehensive understanding of ecological systems and all other elements that have an impact on the dynamics of HABs. The information presented here has the potential to contribute to a more comprehensive evaluation of the effects that HABs have on ecosystems and human health, as well as to provide suggestions for how these effects might be mitigated.

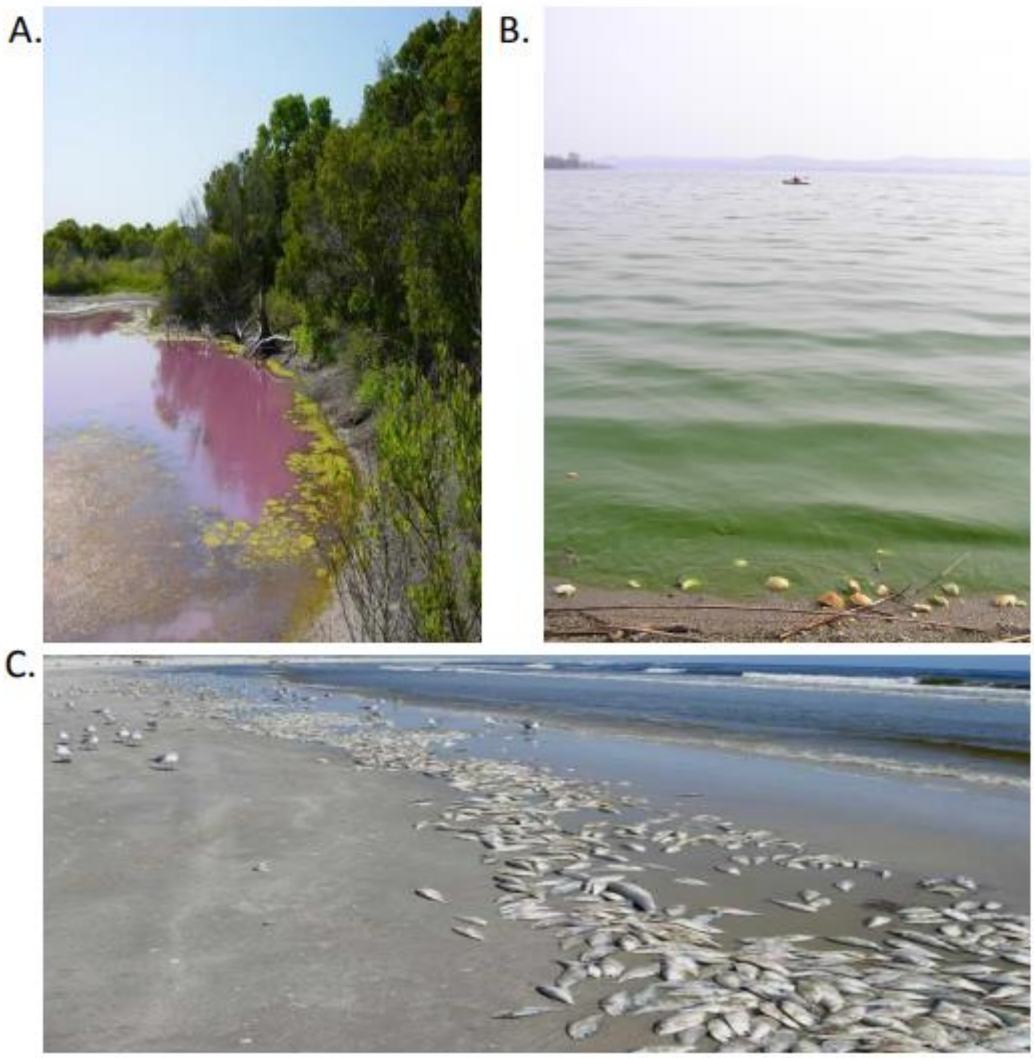

Figure 1: Harmful Algal Blooms (HABs) episodes and effects on fish

Principal groups of organisms generating Algal Blooms

Diatoms

There are around one hundred species of diatoms, which are unicellular, photosynthetic eukaryotes that may be found all over the world in both marine and freshwater environments. There is a significant contribution that marine diatoms make to the aquatic environment, as they are responsible for forty percent of the primary production in marine ecosystems and twenty percent of the world carbon fixation. They also make a contribution to the carbon, nitrogen, and silica cycles that occur in the ocean. Diatoms have developed complex techniques to adapt and respond to environmental stress factors such as nitrogen and phosphate restriction. These tactics have contributed to the evolution of diatoms. The modulation of the proteasome level is particularly important for diatoms because it allows them to adapt their metabolism in response to changes in their environment and to improve their ability to tolerate stress. The majority of diatoms have spines that may physically obstruct and harm fish gills, which can ultimately result in the fish's death. Diatoms are distinguished by their siliceous cell walls, which are called fraughtules. Domoic acid is a neurotoxin that is structurally linked to glutamic acid and kainic acid. It is produced by diatoms belonging to the genus Pseudo-nitzschia. Through filter-feeding species like shellfish or finfish, it makes its way into the food chain. In addition to being implicated in the toxicity that occurs in wild animals like California sea lions, it has a detrimental effect on the growth rate of scallops. Amnesic Shellfish Poisoning (ASP) is a condition that can occur in humans who consume shellfish or crustaceans. The symptoms of ASP include disorientation, loss of short-term memory, headache, and in extreme cases, death. Cases of human intoxication and worldwide changes to the marine food chain demonstrate, therefore, how the evaluation of the risk posed by domoic acid is intimately tied to the necessity of protecting both human health and food safety.

Algal Blooms incidence

There has been an increase in the number of reports of harmful algal blooms (HABs) all over the world. Many of the objectives of the study on HABs include the monitoring of their recurrence and the influence they have on human health, fishery resources, and the overall health of ecosystems. A database that contains records of harmful algal events that have occurred in marine environments all across the world is called the Harmful Algal Events Dataset (HAEDAT) (Figure 3). There are single nations in Europe that are responsible for reporting HAB incidents to the HAEDAT inventory. Table 3 provides a summary of the primary institutions that are responsible for providing data for the HAEDAT dataset as well as marine monitoring projects that are currently on-going at the national level. Since 1985, the International Council for the Exploration of the Sea (ICES) region (North Atlantic) has been contributing records to the HAEDAT database. Additionally, the North Pacific Marine Science Organization (PICES) area (North Pacific) has been contributing records since the year 2000. The number of occurrences that are now included in HAEDAT is displayed in Figure 4, which compares the various nations. The Intergovernmental Oceanographic Commission (IOC) in North Africa, South America, and the South Pacific and Asia are getting ready to make a contribution. A significant amount of information is supplied for each and every harmful algal event that is included in the dataset. This information includes the location, the date of occurrence and duration, the species that caused the event, the related syndrome and toxins that were involved, the type of the event, and the resources that were involved. As shown in Figure 5, the total number of harmful algae events that are included in the dataset is broken down according to the symptom that is linked with them. These syndromes include diarrheal shellfish poisoning (DSP), paralytic shellfish poisoning (PSP), cyanobacterial toxin effects, and aerosolized toxin effects. A relatively limited number of cyanobacteria-related incidents have been documented up to this point, in contrast to the vast majority of incidents that are associated with shellfish toxins, including DSP, PSP, and Amnesic Shellfish Poisoning (ASP). In Figure 6, the overall number of occurrences is broken down according to the type of the event. The majority of the incidents that have been reported are related with seafood toxins, which is probably also attributable to increased monitoring of sea food for public health concerns. Also recorded are a significant number of instances of high phytoplankton concentrations and water coloring, although the number of instances of fish mass death as a result of anoxic conditions is far lower.

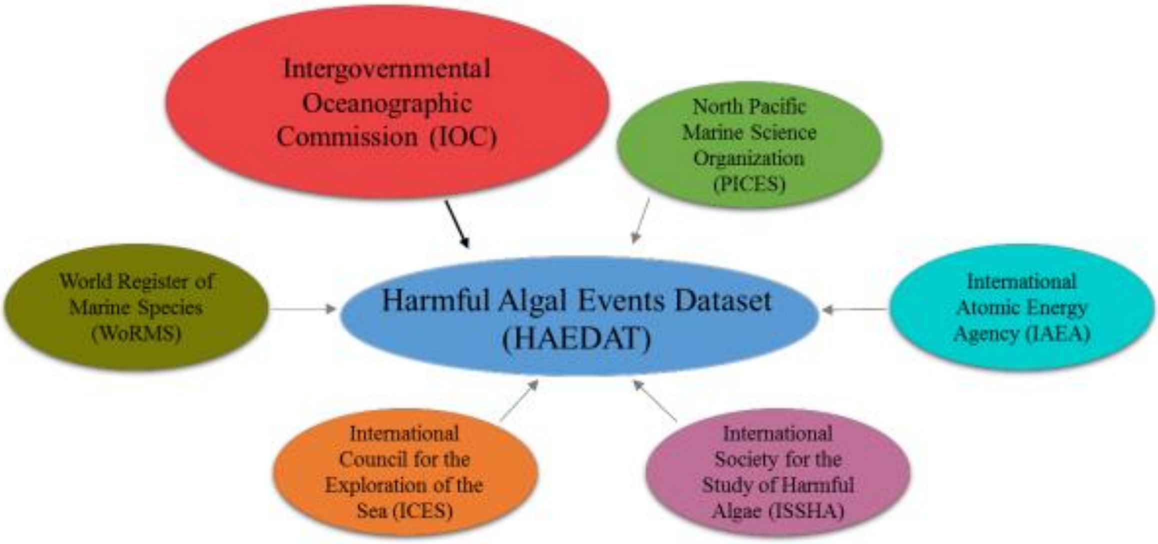

Figure 2: The Dataset of Harmful Algal Events by (HAEDAT)

The Intergovernmental Oceanographic Commission (IOC), which was responsible for the construction of the HAEDET, as well as the other partners contributing to its development are depicted in the picture. HAEDET was developed within the framework of the "International Oceanographic Data and Information Exchange" (IODE) of the International Organization for Science and Culture (UNESCO), in collaboration with the World Register of Marine Species (WoRMS), the International Council for the Exploration of the Sea (ICES), the North Pacific Marine Science Organization (PICES), the International Atomic Energy Agency (IAEA), and the International Society for the Study of Harmful Algae (ISSHA).

Fungi for Algal Control

As a result of their capacity to inhibit the growth of algae, algicidal fungi play a crucial role in the management of algal populations within aquatic habitats. The principal mechanism by which they kill algae is by the production of bioactive chemicals, which either prevent algae from growing or entirely eliminate them. Allelochemicals that are created by fungus have the potential to cause oxidative stress in microalgae, which can impede their development and cause disruptions in their biological activities. To be more specific, active metabolites have the ability to reduce chlorophyll, which is an essential pigment for photosynthesis, in organisms like Heterosigmaakashiwo, which might potentially hinder the process of photosynthesis happening.

A number of algicidal fungi have been recognized, including Trametes versicolor F21a, Bjerkanderaadusta T1, Lophariaspadicea, Phanerochaetechrysosporium, Trichodermacitrinoviride, and Irpexlacteus T2b. It is well recognized that these fungi produce enzymes and secondary metabolites that have the potential to impair the integrity of algal cells, block photosynthesis, or cause oxidative stress.

It has been shown that there is an increase in algicidal fungus during the decrease of algal blooms. This suggests that these fungi play a significant role in preventing and maybe reversing damaging algal bloom episodes by directly targeting excessive algal development.

A number of studies have shed light on the intricate interactions that take place between cyanobacterial cells and fungal mycelia. These studies have revealed that cyanobacteria, both living and dead, first attach themselves to fungal mycelia before being overpowered by the mycelial network. To be more specific, it is well-known that the mycelia of P. chrysosporium are capable of suffering substantial damage to the cell membranes of cyanobacterial organisms, with chlorophyll being a chemical that is especially susceptible to this attack.

Using proteome analysis, Gao et al. conducted a study to investigate the algicidal mechanisms of Trametes versicolor F21a. The findings of this study revealed that numerous biological processes, such as the activities of glucan 1,4-α-glucosidase and hydrolase, play a crucial role in the elimination of cyanobacterial cells. In addition, this research suggested that the algicidal process is associated with a number of metabolic processes, including glycolysis/gluconeogenesis and amino acid production, and others.

In a comprehensive investigation, the algicidal properties of four different species of Aspergillus fungus were investigated. This led to the discovery of eleven powerful metabolites, the most notable of which were five anthraquinones, four steroids, and two terpenoids. Anthraquinones were shown to be particularly efficient against a variety of algae.

White-rot fungi, also known as WRF, are highly effective in breaking down a wide variety of organic pollutants, such as chlorophenols, polycyclic aromatic hydrocarbons, and pesticides, which results in a major improvement in water quality. This capability highlights the potential of WRF as a useful agent in the fight against excessive development of algae due to its capacity to The ability of WRF to degrade substances is largely attributable to the fact that they secrete extracellular enzymes such lignin peroxidase (LiP), manganese peroxidase (MnP), and laccase, all of which have a wide variety of substrate affinities.

Conclusion

In conclusion, recent developments in the study of algal blooms have substantially improved our capacity to identify, monitor, and forecast the occurrence of these phenomena. In order to improve accuracy and get a better knowledge of the environmental factors that contribute to algal blooms, the use of machine learning, artificial intelligence, and advanced satellite technologies has been the most important factor. The ecological and economic implications continue to be the primary focus of research, which also supports collaboration across disciplines and raises awareness among the general public. The development of efficient mitigation techniques, as well as the protection of aquatic ecosystems and human health, are going to need these efforts, which are very necessary. In order to effectively address the issues that are posed by algal blooms, it is essential to implement proactive policies and sustainable management techniques.

References

[1] Paerl, H.W., Controlling Eutrophication along the Freshwater–Marine Continuum: Dual Nutrient (N and P) Reductions are Essential. Estuaries and Coasts, 2009. 32(4): p. 593-601.

[2] Merel, S., et al., State of knowledge and concerns on cyanobacterial blooms and cyanotoxins. Environment International, 2013. 59: p. 303-327.

[3] Kitsiou, D. and M. Karydis, Coastal marine eutrophication assessment: A review on data analysis. Environment International, 2011. 37(4): p. 778-801.

[4] Christian, B. and B. Luckas, Determination of marine biotoxins relevant for regulations: from the mouse bioassay to coupled LC-MS methods. Anal BioanalChem, 2008. 391(1): p. 117-34.
[5] Chorus, I. and J. Bartram, Toxic Cyanobacteria in Water: A guide to their public health consequences, monitoring and management. 1999.
[6] Hilborn, E.D. and V.R. Beasley, One health and cyanobacteria in freshwater systems: animal illnesses and deaths are sentinel events for human health risks. Toxins (Basel), 2015. 7(4): p. 1374-95.
[7] WH, O., Guidelines for safe recreational water environments. Coastal and Fresh Waters. 2003: Geneva: World Health Organization.
[8] Anderson, D.M., et al., Estimated annual economic impacts from harmful algal blooms (HABs) in the United States. 2000.
[9] Adams, C.M. and S.L. Larkin, Economics of Harmful Algal Blooms: Literature Review. 2013, Final report for Gulf of Mexico Alliance Project #00100304, Tallahassee, FL.
[10] Hamilton, D.P., et al., Costs of harmful blooms of freshwater cyanobacteria. In book: Cyanobacteria: An Economic Perspective, Chapter: 15, ed. N.K. Sharma, A.K. Rai, and L.J. Stal. 2013:
[11] John Wiley & Sons. Zhou, X.; He, Y.; Li, H.; Wei, Y.; Zhao, L.; Yang, G.; Chen, X. Using flocculation and subsequent biomanipulation to control microcystis blooms: A laboratory study. Harmful Algae 2020, 99, 101917.
[12] Demeke, A. Cyanobacteria blooms and biological control methods. Int. J. Fauna Biol. Stud. 2016, 3, 32–38.
[13] Pal, M.; Yesankar, P.J.; Dwivedi, A.; Qureshi, A. Biotic control of harmful algal blooms (HABs): A brief review. J. Environ. Manag. 2020, 268, 110687.
[14] Rodrigues, C.; Cunha, M.Â. Assessment of the microbiological quality of recreational waters: Indicators and methods. Euro-Mediterr. J. Environ. Integr. 2017, 2, 25.
[15] Monsalve, E.R.; Quiroga, E. Farmed shrimp aquaculture in coastal wetlands of Latin America—A review of environmental issues. Mar. Pollut. Bull. 2022, 183, 113956.
[16] Karlson, B.; Andersen, P.; Arneborg, L.; Cembella, A.; Eikrem, W.; John, U.; West, J.J.; Klemm, K.; Kobos, J.; Lehtinen, S.; et al. Harmful algal blooms and their effects in coastal seas of Northern Europe. Harmful Algae 2021, 102, 101989.
[17] Jacquet, S.; Miki, T.; Noble, R.; Peduzzi, P.; Wilhelm, S. Viruses in aquatic ecosystems: Important advancements of the last 20 years and prospects for the future in the field of microbial oceanography and limnology. Adv. Oceanogr. Limnol. 2010, 1, 97–141.