Good research paper about chemical pollutants in the gulf of mexico

Environment, Water

Abstract

Different physical and ecological events along the Gulf of Mexico allows the toxic phytoplankton – red algae to become dominant. The phosphorus-rich nutrient supply encourages phytoplankton succession. The objective of the paper is to study the background of red algae, and why the downstream red tides have only increased over the last couple of decades. The toxic red tides are seen in similar coastal habitats of the western boundary currents China, New Zealand, Japan, and South Africa.

Introduction

The Gulf of Mexico is looked at as a marginal sea as it is linked to the major oceans and the procedures that occur in the major oceans, also take place in Gulf of Mexico. The Gulf Coast region is the main source of fisheries for the United States, and there are many commercial species of fish besides shrimp. There are some unique features of Gulf of Mexico that are not found everywhere. There is massive underlining of salt in Gulf leaks depressions that creates brine pools. Every summer, because of the input from the Mississippi River, a huge area of hypoxia forms along the Louisiana coast and Gas hydrates develop at the seafloor in some parts of the Gulf. Moreover, oil seeps are common that result in slicks. It is also important to recognize the chemistry of the Gulf of Mexico because of the oil and gas production.

The changes in the land-use, drainage of wetlands, crop cultivation, fossil fuel combustion and other factors have altered the global nitrogen cycle significantly. The higher rate of nitrogen input is impacting the quality of the atmosphere and marine environments. While nitrogen is vital to the high

output of coastal regions, a disproportionate supply can lead to detrimental effects. The excess of nitrogen stimulates the production of Microscopic algae that can lead to dense blooms and the dying cells of the algae require a huge amount of bacteria and other microbes to get decomposed. The decomposition process needs huge amounts of oxygen, and this can lower the level of the dissolved oxygen than necessary.

One of the major source of nutrients, and pollutants for the Gulf is the Mississippi River. Another threat is the red tide, or the harmful algal bloom. The higher concentration of plantlike organism is deadly to marine life and can have a serious impact on human health. The explosion of certain kinds of algae, also referred to as harmful algal bloom, can lead to cluster in one area of the ocean. The presence of these algae change the color of the water and make it a shade of rusty red. The Gulf of Mexico often suffers from an overgrowth of the dinoflagellate Karenia brevis that causes Florida red tides. The recent global outbreaks of red algae have far-reaching impacts on similar coastal habitats and have led to increased desertification over the last couple of years.

Red tides mean a high concentration of small, single-celled phytoplankton that are mostly dinoflagellate (Red tide, 2013). As the light gets reflected through the accessory pigments in the cells of the large number of phytoplankton floating on the surface, it makes the water appear as a rusty-brownish color. Other algal species can make the surface of the water brown, green or even purple. The water can also carry its normal color during a bloom. Red tides are not a new phenomenon and have known to occur as far back as the 1700s. They can last for a few week or extend longer than a

year, depending on prevailing physical and biological conditions. Different algae species can create red tides all over the world.

The population of the Dinoflagellates grows exponentially by the simple procedure of fission, thus leading to a massive population bloom within a short time. There could be millions of dinoflagellates in one single drop of water. One of the largest red tide bloom occurred in 2005 near Florida killing thousands of fish. Satellite images indicate the expanse of such blooms that can extend to hundreds of miles, causing an ongoing fish kill as the bloom waits offshore. Currents affecting other beaches can sweep the red tide at the bottom of the ocean.

Background information on red tide

Red tide does not mean that the water becomes red, and it is not affected by the tides. Not all red tides are not harmful, but there are some that can lead to massive damage to the marine life. Red tides are unpredictable but have been occurring more frequently in the recent times. Optimal light and nutrients, warm surface temperatures, along with reduced salinity are some factors that contribute to the blooms. Other factors are burning of fossil fuels and release of phosphates and nitrates into the ocean environment that lead to primary producers to grow rapidly.

There are different algae associated with red tides and the most prevalent in Gulf of Mexico is Karenia brevia, that particularly widespread along the west coast of Texas and Florida. lexandrium catenella is common from Mexico to Alaska throughout the Pacific. What contributes to the red tide's formation are a high nutrient content, low salinity and warmer-than-usual temperatures

of surface water(The ecological condition of estuaries in the gulf of mexico, 1999).

There have been many studies and observations made on outflow of pollution and implications for air quality over the Gulf of Mexico, the Pacific, and western North America. To differentiate K. brevis blooms from other red tides caused by other species of algae, researchers refer to the algae that are widespread in Gulf of Mexico as the Florida red tide(Singh et al, 2009). The Florida red tide is found in bays and estuaries but not in freshwater systems such as lakes and rivers. The reason is that K. brevis cannot thrive in low-salinity waters for very long and can bloom well in salty coastal waters.

Karenia brevis needs three mechanisms to form a bloom. The right biological and chemical conditions, along with the right physical conditions are essential for the Red Tide to occur. Florida red tides often develop at a distance of 10-40 miles offshore and have known to occur long before human settlement. These can last for as little as a few weeks or stay for more than a year. They can subside with time or reoccur, depending on the physical and biological conditions such as sunlight, nutrients and salinity, direction of wind and water currents and other factors that influence its growth and persistence. When and for how long will a red tide occur cannot be predicted. However, scientists can forecast its movement using the current water data and reading the winds. Red tide movement and concentration are very important to follow as it can create massive death in the marine life.

It is seen that Red tides are typically followed by an enormous die-off of fish as well as the birds that feed on the fish. The algae connected to red tides

carry a toxin that disturbs the digestive and nervous systems of animals. Even larger animals that feed the fish and other marine life can be killed if they eat enough of the toxin. In recent times, red tides have caused a huge number of squid deaths in California and significant die-off of manatees in Florida. Humans are susceptible to the deadly effects of a red tide as the algae's toxins released into the air can cause respiratory problems. Extensive blooms of red algae pose the question if they are made of the same species. One comes across maximum growth and salinity tolerance on both sides of the Gulf (Walsh et al, 2006). There are certain physical and ecological events that lead to the dominance of the phytoplankton growth. The phosphorus-rich nutrient supply leads to phytoplankton growth, allowing them to bloom above phosphate-rich mid shelf waters. Sun-adapted diazotrophs and shade-adapted toxic dinoflagellates that both drift vertically to the bottom of the euphotic zone The dead fish serve as supplementary nutrient source and lead to large red tides feeding on decaying diazotrophs and fish.

Why red tide occurs

Rivers are known to carry nutrients and sediments to the ocean due to runoff from farmland and erosion of land. The nutrients are a rich source of food for phytoplankton that live in the ocean surfaces. The primary nutrients that are present in ocean waters are nitrate, phosphate, nitrite, silicate, iron and ammonia (Boatman, 2006). The Mississippi River is the chief source of nutrients to the Gulf of Mexico. Within ocean waters, when plants and animals that live on the surface, die, they sink to the bottom as detrital rain.

The bacteria in the ocean decompose these into basic chemical components, which form nutrients. The supply of nutrients of the Mississippi River have only increased and almost become double (Walsh, 2006). The nutrient filling of the Mississippi River further leads to an extensive red tide, killing millions of fish.

The base of the food chain in the ocean is made of that tiny phytoplankton. These single-celled plants require light and nutrients such as nitrates and phosphates to live and are found near the surface of the sea. When large amounts of nutrients enter the ocean in a short period, the phytoplanktons respond with rapid growth and multiplication. The algae continue to bloom till all the nutrients are gone. Later, the phytoplankton die and sink to the bottom. There are other tiny animals or zooplankton living in the water column along with the phytoplankton. The zooplankton also die and their body parts sink to the bottom. This procedure is known as detrital rain. The remains are eaten by bacteria and decomposed into nitrates, phosphates, and other nutrients. The procedure results in huge volumes of organic matter settling down on the seafloor and a depletion in oxygen. This creates a situation known as hypoxia.

Hypoxia takes place when the concentration of dissolved oxygen in water lowers down to

below 2 mg/liter. Normally, the concentration of oxygen in the water is between 5 and

8 mg/liter. The concentration of oxygen is of interest as fish, shrimp and crabs need oxygen to survive in the ocean. Moreover, they are a major source of commercial fisheries and also a source of food for other fishes. In

the case of hypoxia, the marine animals should leave the area of hypoxia at one. However, some animals cannot leave the area and die. In the recent years, the hypoxia in the Gulf of Mexico is seen to extend all the way to Freeport, Texas, and even to the Texas-Louisiana border. This process occurs more often during the summer, when a sheet of warm freshwater drifts on the top of a cold water. This averts the water from mixing with each other and bringing oxygen from the surface to depth. All these factors including movement of water, the currents, the distribution of chemicals, especially nutrients, in the Gulf of Mexico lead to the bloom of red tide.

Another aspect to the difficulty is seen in the layer of salt below the Gulf of Mexico that was created during the Jurassic period. The addition of sediments into the Gulf basin deform the salt bed structure and those deformations take the shape of domes of salt. The results in cracks and fissure in the covering sediment, leading to the migration of salt to the surface. What happens next is the creation of naturally occurring dense brine pools along the seafloor of the Gulf of Mexico. These pools act like a trap for sediment and organic matter, and nothing can live in the brine pools.

Recent studies show that red tides are occurring more frequently now and can last for months. Although confined mainly to the coastline along the Gulf of Mexico, the algae can travel as far north as North Carolina. Even humans when exposed to offshore brevetoxins, have reported experiencing symptoms and breathing problems.

Red tide affects different aspects of life

Controlling Florida red tides is not an easy matter and the harmful effects are seen when toxins are released after the organism dies. Potential controls must not only remove the red tide organism but also get rid of the toxins from the water. There has been no solution till date and whatever controls strategies are being worked on, should also not harm the environment. Red tides can cover thousands of 10, 000 square miles and can extend from the surface of the water to the seafloor.

It has been found that almost 40% of oil products that fall into the ocean create a stable oil emulsion. Another 40% settles to the bottom, while the rest forms a surface film. Oil can stick to the algae and shells of aquatic animals (Jafar, 2014), as well as . prevent movement, breathing and nutrition of small aquatic organisms. Thus, the presence of oil in the ocean has a detrimental effect on organisms. Gulf of Mexico oil pollution led to mass death of fish.

People who eat brevetoxin-contaminated clams and oysters develop acute neurological and gastrointestinal symptoms. They report coughing, irritated eyes and wheezing when brevetoxin aerosols blow ashore. However, most of the symptoms subside when people leave the beach or enter air-conditioned buildings. Asthmatics are more vulnerable to red tide aerosols. During red tide blooms, people have reported chest tightness and are advised to avoid beaches deign K. brevis bloom.

Marine Laboratory studies have shown that red tide toxins that are airborne can travel up to a mile inland, according to the weather patterns. Thus, even if one is several miles away from the sea coasts, you can still get affected by

the toxins. People with asthma and other respiratory problems need to be extra cautious. Limit your outdoor activities if you feel discomfort and keep away from the barrier islands. Seek medical care immediately if required or the symptoms do not go away.

Controlling Red Tide

Harmful Algae blooms occur worldwide and produce toxins that kill marine organisms, foul the air and cause skin irritations. The Red tides are known to impact commercial fisheries and seem to increase in size, intensity, and persistence. Coastal economies are suffering millions of dollars of losses due to these algae blooms each year. Scientists and researchers from universities are looking for systems that can trail and predict harmful algal blooms (Boesch, 1997). There are sensors that can identify dangerous microscopic algae by their genetic material and offer an early warning. Field observations and forecasting system based on satellite imagery information can help to map blooms and predict how they will spread. Timely detection can help scientists and public officials to give alerts and minimize harm to humans and marine life.

It must be recognized that an effective management of harmful algal blooms and the toxic associated with the blooms is not that easy. Modern technologies and progress made in this direction offer new potential to trace the individual toxins. It is essential to make a deeper research of the role played by habitat alteration and altered hydrology that lead to increasing occurrence of HABs. There is a need to develop methods and policies to inverse the occurrences of red tide or keep them in check.

Conclusion

Harmful algal blooms are a growing problem in marine waters and currently, there are no permanent solutions or possible control strategies available. The scientists and funding agencies are doing serious research on the subject. It is essential to conduct a series of large-scale examinations and research on red tides. Uncontrolled water resources pollution due to gas, oil and other dangerous substances can lead to blooms of red algae, under certain conditions. The favorable status of aquatic ecosystems is crumbling under the pressures of economic profit. It is getting more challenging to implement the project of sustainable development. Thus, more affords are needed in this direction and steps should be taken to create awareness regarding the issue.

Different characteristics in the Gulf of Mexico and a combination of environmental factors may lead to changes in the composition of the water and its life. Several factors work together behind the creation of red tides such as turbidity, salinity, depth, temperature, phytoplankton growth, nutrient enrichment, and pollution. The past info on the state of the estuarine environment in the Gulf of Mexico region and based on the current state of knowledge are important to understand the red tides. Every indicator and factor are important for understanding estuarine condition and the reason behind the red tides.

Scientists are already studying how the changing ocean temperatures, weather patterns and currents are associated with Florida red tides. The issue is of bigger concern as the recent blooms are not only getting bigger in size but lasting longer. The impacts are detrimental to the marine

ecosystem, and it is going to take long-term data sets to make conclusions. The changing ocean temperatures and weather patterns may be affecting Florida red tides. The scientists are concerned about the issue, what with the recent blooms getting bigger and lasting longer. Chemical pollution is one of the greatest threats to the gulf of Merxico. The potential toxic chemicals entering the gulf via several means could extend the problem. The higher rate of nitrogen input is already impacting the quality of the atmosphere and the marine environments. Excess of nitrogen stimulates the phytoplankton into high production, leading to a cascade of detrimental effects. The dense growths, substantial amounts of oxygen used for the decomposition process lead to the lower oxygen resupply or the condition of 'hypoxia'. The oxygen-depleted area is also known as 'dead zone' that may cover thousands of miles. The conditions get triggered by the high influx of nutrient-laden freshwater brought down from the Mississippi and are typically formed in May and can remain for months (Mississippi flooding leaves a toxic legacy: Pollution in gulf of mexico1993) . The conditions leading to hypoxic water are well known and the impacts in the Gulf of Mexico include mortality of organisms and high losses of bottom-dwelling plants.

There is no denying in northern Gulf of Mexico that has experienced noteworthy changes over the last decades due to human activity, nutrient pollution and damage to seabed habitats. Serious detrimental impacts will continue if Red algae tides are not checked. The availability and mobility of nitrogen are fast becoming a scientific concern as it poses wide-reaching threats and risks to human health. The increase in the availability of nitrogen has become an issue of global significance and scientific concern recently.

They lead to a range of impacts in coastal waters increasing harmful algal blooms and declining commercial fisheries.

References

Red tide (2013). Sage Publications.

Mississippi flooding leaves a toxic legacy: Pollution in gulf of mexico: All 09/07/93 edition.

(1993,). The Christian Science Monitor (Pre-1997 Fulltext), pp. NOPGCIT.

The ecological condition of estuaries in the gulf of mexico / J. kevin summers, project officer

(1999).

Singh, H. B., Brune, W. H., Crawford, J. H., Flocke, F., & Jacob, D. J. (2009). Chemistry and

transport of pollution over the gulf of mexico and the pacific: Spring 2006 INTEX-B

campaign overview and first results. Atmospheric Chemistry and Physics, 9(7), 2301-2318.

J. J. Walsh, G. A. Vargo, R. H. Weisberg, K. A. Fanning, F. E. Muller-Karger, E. Shinn, . . . F.

R. Chen. (2006). Red tides in the gulf of mexico: Where, when, and why? Journal of

Geophysical Research - Oceans, 111(C11), C11003

Boatman, M. (2006). Chemistry in the Gulf of Mexico. Minerals Management Service.

Jafar, J. (2014). Toxic Chemical Pollution Of Water Resources As A Threat To

The Sustainable

Development. Sumy State University.

Boesch, D. F., National Fish and Wildlife Foundation (U. S.), & United States.

NOAA Coastal

Ocean Program Office. (1997). Harmful algal blooms in coastal waters:

Options for

prevention, control and mitigation. Silver Spring, MD: National Oceanic and

Atmospheric

Administration, Coastal Ocean Office.