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2. Emerging Issues Regarding the Intersection of Climate, Toxic Substances, and Environmental Health

Dr. Anupama
Assistant Professor
Govt. Science P. G. College, Sikar.

Pooja Kumawat
Assistant Professor,
Department of Chemistry,
Shri Kalyan Rajkiya Kanya Mahavidyalaya,
Sikar, Rajasthan.

ABSTRACT

Climate change caused by anthropogenic warming of the earth's atmosphere is a frightening prospect. The focus was on three broad classes of chemical toxicants of global significance: air pollutants, persistent organic pollutants (POPs), including some organochlorine pesticides, and other pesticide classes. Temperature increases, in general, will increase the toxicity of contaminants and regional tropospheric ozone concentrations, but will also likely increase rates of chemical degradation. Climate and environmental change (C-E-C) are to have an impact on people's health and quality of life. The impact of C-E-C on food supply and food as a vehicle for exposure have received a lot of attention. C-E-C, on the other hand, has been superimposed on widespread malnutrition, infectious and noncommunicable diseases. We discuss why nutrition should not be confused with food and should be viewed as a biological variable that influences and is influenced by both C-E-C and current global health challenges. The relationship between C-E-C, food, nutrition, and health must be considered when developing safe and effective interventions.

KEYWORDS:

Chemicals; Consumer products; Exposure; Health risks; Environmental Health, Toxic Substances, Climate.

1. Introduction:

Toxins in the environment are unavoidable. They are present in the food we eat, the water we drink, the air we breathe, and many everyday household items. Because they are mostly invisible, they go unnoticed and are harmless if exposure is limited. Growth in industrial manufacturing, fossil fuel consumption, and chemical-intensive crop production, on the other hand, has dramatically changed the scale and complexity of human exposure to environmental toxins, which can cause mild skin irritation to fatal illness.

It is not as simple as identifying and eliminating harmful substances to address the threat that environmental toxins pose to public health. Many of the products and methods that contribute to pollution are essential to modern life, and efforts to reduce their use are hampered by a lack of research into their effects as well as successful economic forces. [1]

Toxic chemicals are poisonous substances that can harm living beings. Radon in the air - both indoors and outdoors, lead in drinking water and lead-based paints, car exhaust fumes, and arsenic in rice, apples, and grape juices are just a few examples of toxic substances that can harm your health. Toxic substances do not degrade easily in the environment and can enter or contact the body at any time through the food or water we consume. They can even accumulate in the food chain and harm the organisms that live in it. Here are some examples of how toxic chemicals can be disastrous. Acid rain is caused by nitrogen and sulphur oxide emissions from automobiles, which mercilessly kills trees and fish in rivers and lakes. Acid rain can cause serious environmental issues.

Toxic waste disposal has become a global challenge. Every year, the world's nations generate 440 million tonnes of toxic waste. Given the covert nature of the operation and the fluid definitions of what constitutes hazardous or toxic waste, this is a very conservative estimate. [2] Hazardous waste is defined by the United States Environmental Protection Agency as "waste with properties that make it dangerous or potentially harmful to human health or the environment" (U.S. Environmental Protection Agency 2006).

Liquids, solids, contained gases, sludge, byproducts of manufacturing processes, or simply discarded commercial products, such as cleaning fluids or pesticides, can all be classified as hazardous waste. The greenhouse effect, which accounts for global warming is caused by carbon dioxide gas. Several human activities, including transportation and deforestation, have contributed to rising carbon dioxide levels in the atmosphere.

Toxic chemicals are found in our soil, water, and air, and they can also be found in our bodies. Exposure to these contaminants has posed a threat to the health of humans and animals worldwide. Indeed, even human waste contains harmful toxins and chemicals that cannot be broken down by natural processes, resulting in soil contamination. Environmental testing laboratories can identify any toxic substances or pollutants in the environment.

2. Toxic Substance:

A toxic substance is a poisonous agent or chemical that is harmful to the body's health. Many people are regularly exposed to a variety of toxic substances, whether through home use or workplace exposure. A variety of factors contribute to harmful pollutants affecting people, including age, duration of exposure, general health, pregnancy, and alcohol consumption. Many chemicals cause acute or chronic health effects such as nasal passage, skin, and/or eye irritation (acute) or the development of cancer (chronic) over time. [3]

Toxic substances can enter the body through ingestion, inhalation, or direct skin contact. Depending on factors such as potency, ambient concentration (dose), body size composition (adult, child), and mode of entry, chemical products can cause a variety of health problems. Identifying a single hazardous cause in individuals exposed to multiple substances can be difficult, especially if chronic exposure is involved.

As a result, epidemiological symptoms can be delayed from the point of initial contact until a health condition develops, a period known as the latency period. Certain chemicals can cause temporary or permanent health effects. Toxins that enter lung tissue, such as asbestos, can enter the bloodstream and spread carcinogens to other organs, jeopardising overall health. Although an individual's exposure to asbestos may end, cancer cells continue to proliferate and spread in the body long after the exposure.

Environmental Toxins:

Environmental toxins, in general, are substances and organisms that have a negative impact on health. Poisonous chemicals and chemical compounds, physical materials that disrupt biological processes, and pathogenic organisms are among them. The consequences of being exposed to environmental toxins are numerous. Carcinogens, as well as substances affecting cardiovascular, endocrine, and respiratory functions, are major threats. [4]

Toxicology:

Toxicology, or the science of poisons (from the Greek toxicos - poisonous and logos), is a branch of biology and medicine closely related to pharmacology. Unlike pharmacology, it investigated various chemicals' toxic effects on other living organisms, particularly humans. Dose is the most important criterion for determining a substance's toxicity. If the dose is large enough, almost all given substances become toxic.

Many toxic substances are only potentially toxic through their toxic metabolites. Methanol is one of these substances; it is not toxic in and of itself, but it is metabolised in the liver to toxic formic acid and formaldehyde. Some drugs become toxic after being converted in the liver. Another example is paracetamol, which is found in pain relievers. Paracetamol overdoses produce a toxic metabolite that harms the liver. [5]

The list of toxic chemicals is excessively long. Even essential elements required by biological systems (for example, Fe, Cu, Zn, Mo, Co, V, Mn, Na, K, Ca, Mg, F) may be toxic above a certain level. Some elements, on the other hand, play no beneficial role and are toxic even at very low concentrations. Toxic elements include As, Sb, Cd, Hg, Be, Al, Pb, and others. There are numerous pollutants in the atmosphere, including SO_x, NO_x, PAN, and other toxic chemicals.

Pesticides and insecticides can pollute the atmosphere, hydrosphere, and soil, making them toxic chemicals. Radioactive substances are another example of toxic chemicals. Hazardous substances include chlorinated solvents, chlorofluorochemicals, ethylenedibromide, ethyleneoxide, nitrosoamines, nitro compounds, polychlorinated biphenyl (PCB's), vinyl chloride, and other organic compounds. Some toxic compounds may be carcinogenic, mutagenic, or teratogenic. [6]

Toxic substances include -

- Ozone, white phosphorous, elemental halogens, heavy metals such as cadmium, beryllium, lead, arsenic, and mercury, among other things.
- Cyanide (both HCN and cyanide salts), CO, nitrogen oxides (NO & NO_2, N_2O), nitrates, hydrogen halides (HF, HCl), interhalogen compounds (BrCl, ClF, BrF_3), and halogen oxides are examples of toxic inorganic compounds (OF_2, Cl_2O, ClO_2, Cl_2O_7, Br_2O).
- Silicon inorganic compounds (SiO_2, quartz), silane (SiH_4), disilane, and so on.
- Phosphine (causes pulmonary tract irritation, central nervous system depression, fatigue, vomiting, and painful breathing), P_2O_5, and $POCl_3$ are examples of inorganic phosphorus compounds.
- Sulphur inorganic compounds - H_2S, SO_2, H_2SO_4, S_2F_2, SF_4, SF_6, S_2Cl_4, SO_2Cl_2, $SOCl_3$, COS, CS_2.
- Organometallic compounds include organolead and organotin compounds, carbonyls such as nickel tetracarbonyl, cobalt carbonyl, and iron pentacarbonyl, among others.

Toxic effects of chemicals can be modified by:

- Chemical factors
- Factors associated with treatment
- Biological factors
- Environmental factors

Effects of Some Toxic Chemicals:

1. **Arsenic:** Arsenic is a naturally occurring semi-metallic chemical. Arsenic can enter the body through contaminated groundwater, surface water, or infected soil.
   If not treated, arsenic poisoning can result in serious illness and even death. If a dangerous amount of arsenic enters the body, it can disrupt cellular metabolism. Increased arsenic levels can cause cancer, liver disease, cellular metabolism disruption, and even coma. Anyone who suspects high arsenic levels in their local environment should seek further information from environmental testing laboratories. [7]
2. **Lead:** The harmful effects of lead have been undermined until now due to its widespread industrial use. Lead is a toxin that accumulates over time. It is extremely dangerous for children. Lead poisoning causes constipation and abdominal pain in the gastrointestinal system. It also causes nervous system damage and sleep disorders. It depletes your energy reserves and causes fatigue.
3. **Mercury:** It is a heavy metal that is highly toxic in nature. Mercury exposure, even in trace amounts, is harmful to foetal development. Mercury is poisonous to the kidneys and the immune system. This toxic chemical can be harmful to the eyes, lungs, and skin if consumed.
4. **Cadmium:** Cadmium concentrations in the environment that exceed a certain threshold can be toxic to biota. Freshwater organisms, such as shellfish, have been known to accumulate cadmium at levels that can be harmful to consumers who consume them, resulting in foodborne illnesses.
5. **Petrochemicals:** Petrochemicals have become an important part of our lives as a result of our reliance on crude oil, but they can be hazardous to human and animal life. Oil

and petrochemical coatings on the sea layer prevent sunlight and oxygen from reaching the water's vegetation and microbial life. Petrochemicals, when burned, emit nitrogen, sulphur, and carbon into the atmosphere, which can contribute to acid rain. Unburned petrochemicals, such as carbon monoxide, can cause lung disease in humans while also contributing to global warming. Exposure to petrochemicals in pregnant women can result in birth defects in future children.

6. **DDT Pesticides:** Because of its widespread use in pesticides, it has made its way into our food chain. DDT has caused population declines in animals near the top of the food chain, such as the bald eagle and the peregrine falcon. Direct skin contact with DDT can result in skin infections, tingling, or creeping. Humans may experience vomiting, nausea, and tremors or shakiness after being exposed to DDT. Prolonged DDT exposure can result in liver cancer, birth defects, and other reproductive harm. Environmental laboratories can help protect the environment from potentially hazardous DDT.

3. Review of Literature:

Toxic substance emissions by industries are common all over the world. Every day, industries and anthropogenic activities emit toxic substances. Toxic substances are classified into three types: organic, inorganic, and metallic compounds. Methane, sulphate, and mercury are examples of organic, inorganic, and metallic compounds, respectively.

There have been reports of these substances having negative environmental effects. Substances such as methane are to blame for rising atmospheric temperatures. Sulfates have an impact on soil. Acid water is formed when sulphates react with atmospheric water. Acidic water harms soil and microorganisms that live in it. Mercury, on the other hand, has an adverse effect on water. The presence of more mercury in water has an impact on aquatic organisms (Gregg & Losey et al., 2009) [8]

The primary sources of methane emissions are thought to be natural gas and petroleum. In order to reduce the rate of methane emissions, industries are turning to efficient modes of transportation. As previously stated, petroleum and natural gases are the primary sources of methane.

As a result, good transportation methods for petroleum and natural gas reduce methane gas emissions into the atmosphere. Second, industries are implementing methane capture technologies. These technologies capture methane and reuse it. Pneumatics, dehydrators, plunger lifts, vapour recovery units, rod packing, composite wrap, and pipeline pump down are examples of these technologies (Kevin & Roger, n.d.). [9]

Sulfate, unlike carbon dioxide, is not a common pollutant of the environment. Sulfate is produced during the combustion of sulphur dioxide. There are microscopic particles in it. After the combustion of fossil fuels, sulphur dioxide is released. Because sulphur dioxide is unstable, its release into the atmosphere results in the formation of sulphate compounds. In the presence of oxygen, it readily reacts with moisture to form sulphate compounds. Because these compounds are predominantly acidic, they are harmful to the environment. When combined with oxygen, sulphate products are formed. Sulfate is made up of sulphur and four oxygen molecules (Hand et al., 2012; Lajtha & Jones, 2013). [10]

Sulfate emissions from industry have a negative impact on the environment and human health. Sulfate aerosols cool the atmosphere. It accomplishes this by reflecting radiated particles and influencing cloud formation. Solar radiation is absorbed by sulphate aerosols. It keeps radiation from reaching Earth. This has a cooling effect on the earth's surface, which affects wildlife. Sulfate aerosols cause the formation of acidic compounds. Acid rain is formed when sulphate reacts with atmospheric vapour. Acid rain harms plant growth, corrodes roofs, and destroys soil microorganisms. Sulfate also causes lung irritation. It also contributes to ground-level haze (Hausefather, 2008). [11]

Various techniques are used by businesses to eliminate or reduce the amount of mercury emitted into the environment. The first method used by industries is to reduce the use of raw materials that cause mercury emissions into the atmosphere. Industries are now choosing to use raw materials that are either free of mercury or have a low mercury content. Some industries are now utilising alternative energy sources, such as natural gases. Industries are switching from coal to this. On the contrary, some industries are using coal that contains less mercury. Second, companies are developing products that do not contain mercury. This is known as substituting products. This is the point at which industries decide to produce products that contain no traces of mercury. This contributes to a reduction in the amount of mercury reaching consumers (Mercury, 2014). [12]

4. Objectives:

- To study biological and chemical components of particulate matter
- To study dynamic phase of toxicant action in which a toxicant interacts with an endogenous receptor
- To study toxicological chemistry
- To study effects of toxic chemicals

5. Research Methodology:

A research methodology is a method for solving a research problem in a systematic manner. It can be thought of as a science that studies how scientific research is conducted. In it, we look at the various steps that a researcher takes when studying a research problem, as well as the logic behind them. The researcher must understand not only the research methods/techniques but also the methodology. A close reading and detailed analysis of secondary sources is required in order to apply the analytical and descriptive methods to the research. It is critical to obtain additional perspectives in order to expand on the textual analysis, which would necessitate close reading analysis of a few secondary materials.

6. Result and Discussion:

Toxicological chemistry is the study of the chemical nature and reactions of toxic substances, including their origins, applications, and chemical aspects of exposure, fate, and disposal. Toxicological chemistry studies the interactions between molecules' chemical properties and molecular structures, as well as their toxicological effects. The definition of toxicological chemistry is depicted in Figure 1. [13]

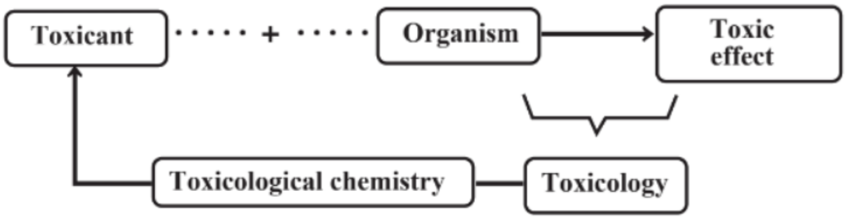

Figure 1: The biochemical science of toxic substances and their precursors is known as toxicological chemistry. Toxicological chemistry is concerned with the nature and reactions of these substances in relation to toxicology.

A common example of a biochemical effect occurs when a toxicant binds to an enzyme, preventing the bound enzyme from performing its normal function. There is a response, such as a behavioural or physiological response, as a result of a biochemical effect, which constitutes the actual observed toxic effect. Binding to nerve gas inhibits the acetylcholinesterase enzyme. Sarin may fail to inhibit nerve impulses in the breathing process, resulting in asphyxiation. The phenomena just described take place during the dynamic phase of toxicant action, as illustrated in Figure 2[14].

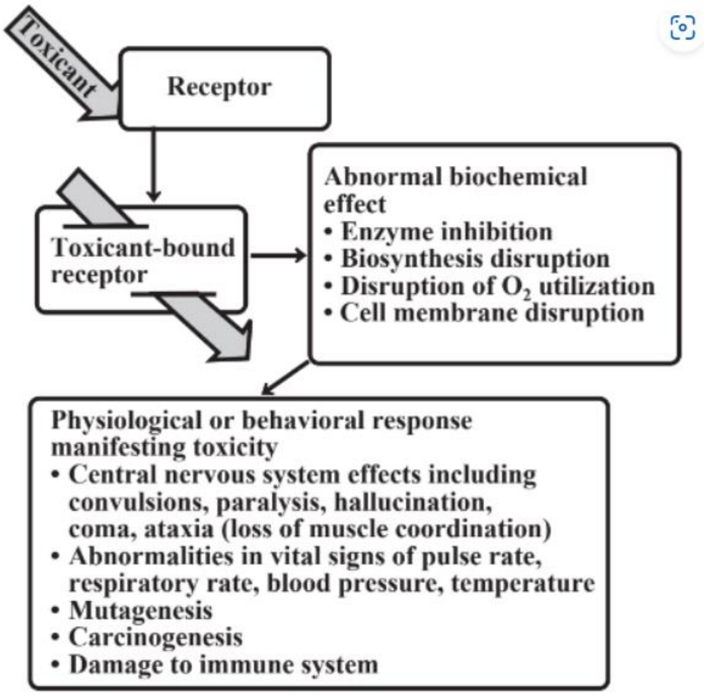

Figure 2: depicts the dynamic phase of toxicant action, in which a toxicant interacts with an endogenous receptor, causing biochemical changes that harm an organism.

PM has a variety of physical properties (particle size and number, total surface area, and electrostatic properties), as well as biological and chemical components (Figure 3) [15].

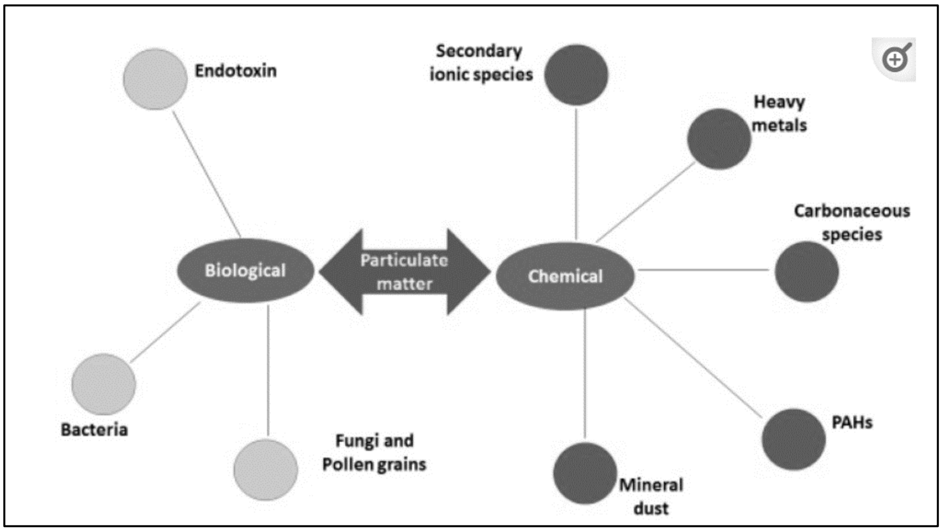

Figure 3: Biological and chemical components of particulate matter

The biological elements, also known as bioaerosols, are a mix of viable and non-viable microorganisms as well as other types of biomass suspended in the atmosphere with sizes ranging from 0.1 to 100 m. [16] Fungal spores, fragmented pollen, and non-agglomerated bacteria prefer to attach in the coarser particulate fraction, but they can also be found in the fine fraction.

Table 1: shows the effects of global climate change (GCC) on various assessment and management processes for legacy pollutants.

Decision question being asked	Who?	How is the decision question now answered?	What will be the implications of GCC on the decision-making process?	Probability and magnitude of GCC impact	What other changes might take place?	Recommendation
Monitoring						
What are the concentrations of legacy pollutants in the environment and food supply?	Regional, national, and international regulatory and public-health agencies	Legacy pollutants such as mercury and legacy POPs are tracked in air, water, soil, food, and biota. There is also a strong reliance on fate modeling to interpret future trends and provide more spatial resolution.	Legacy pollutants can be more easily mobilized by climate disruption and can have altered phase distributions in warmer climates.	High probability of change in higher latitudes and at higher elevations. Moderate probability of change in other regions.	Higher-resolution environmental and biospecimen monitoring capacity	Expanded modeling studies combined with strategic environmental sampling to track the magnitude and variation of altered transport patterns for legacy pollutants, particularly in higher latitudes. Careful attention to food-web contamination is needed.
Strategic forecasting						
How safe are the levels of legacy pollutants in the food supply and breast milk?	Regional, national, and international regulatory and public-health agencies	Analysis of food concentrations compared to guideline levels established using data from toxicological tests and predicted food concentrations	Food commodities in some regions, particularly for subsistence populations, may need to be replaced or consumption curtailed; fish advisories and other public information programs likely will also be affected.	High probability of increased exposure, but significant geographic and population variability are likely.	Availability of seafood could be more substantially impacted by GCC or overfishing than anticipated.	Decision makers should exercise adaptive management to address changes, based on effective use of expanded models and limited observations. Models used to support selection of chemicals of concern for the Stockholm Convention on POPs should be reevaluated.

Regional and global migration shapes will be altered if GCC results in heavy winds and/or stronger river, lake, estuary, and ocean currents. Legacy pollutants' perseverance is dependent on chemical transformation, some of which are climate-dependent. It will be necessary to comprehend the potential effects of GCC on processes such as hydrolysis and biotransformation, which are critical in the removal of chemicals from environmental media such as soil, water, and sediments.

Chemicals must travel through a pathway known as the source-to-receptor pathway before they can directly affect humans. Chemical compounds must come into contact with and enter the body of a human after being released from some source and starting to move through environment, often being converted by physical or biological factors in the process. Once in the body, chemicals undergo human toxicokinetic processes before coming into contact with a target tissue or molecular receptor and causing an adverse reaction (Figure 4).

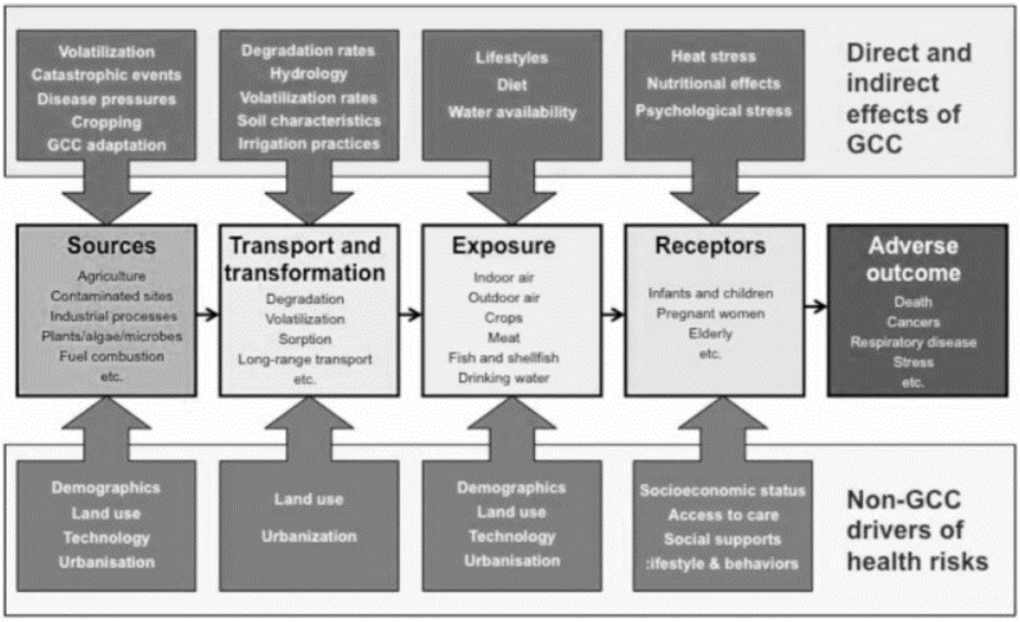

Figure 4: depicts the source-pathway-receptor relationship in relation to both climate and nonclimate stressors. GCC stands for global climate change.

Table 2: shows the effects of global climate change (GCC) on various assessment and management processes for natural toxins.

Decision question being asked	Who?	How is the decision made now?	What will be the implications of GCC on the decision-making process?	Probability and magnitude of GCC impact	What other changes might take place?	Recommendation
Monitoring						
Is the level of a natural toxin (e.g., mycotoxin or algal toxin) safe?	Regulatory and public-health agencies, food industry	Occurrence of some natural toxins is measured in food samples and concentrations are compared to a standard or advisory guideline.	Outbreaks of fungal infections and algal blooms will occur more frequently under GCC. More rigorous monitoring may be required to pick up exceedances.	High probability in some regions, high magnitude	None anticipated	Modeling studies to explore likely prevalence of natural toxin food contamination incidents in different regions and evaluation of existing monitoring regimes against these predictions.
Strategic forecasting						
Do natural toxins pose a threat to food security?	Regulatory and public-health agencies, public-health researchers	Analysis of monitoring data on the occurrence of natural toxins in food	Outbreaks of fungal infections and algal blooms will occur more frequently under GCC, resulting in reduction in the availability of safe food in some regions.	High probability, magnitude of changes uncertain	None anticipated	Apply plant infection models that account for climatic effects for different regions under GCC.
						Apply modeling to explore likely increases in algal blooms under GCC in different regions.

Policymakers at the national and international levels will be interested in the potential effects of the GCC on the occurrence of natural toxins and the subsequent impacts on food security in various regions. An examination of the implications of the GCC on the monitoring of natural toxins for food safety (Table 2) indicates that, due to the likely increase in occurrence, existing monitoring mechanisms may be insufficient to protect human health in the future.

Because there are too many variables to consider, it is clear that climate change will have an impact on aquatic toxins blooms, both marine and freshwater.

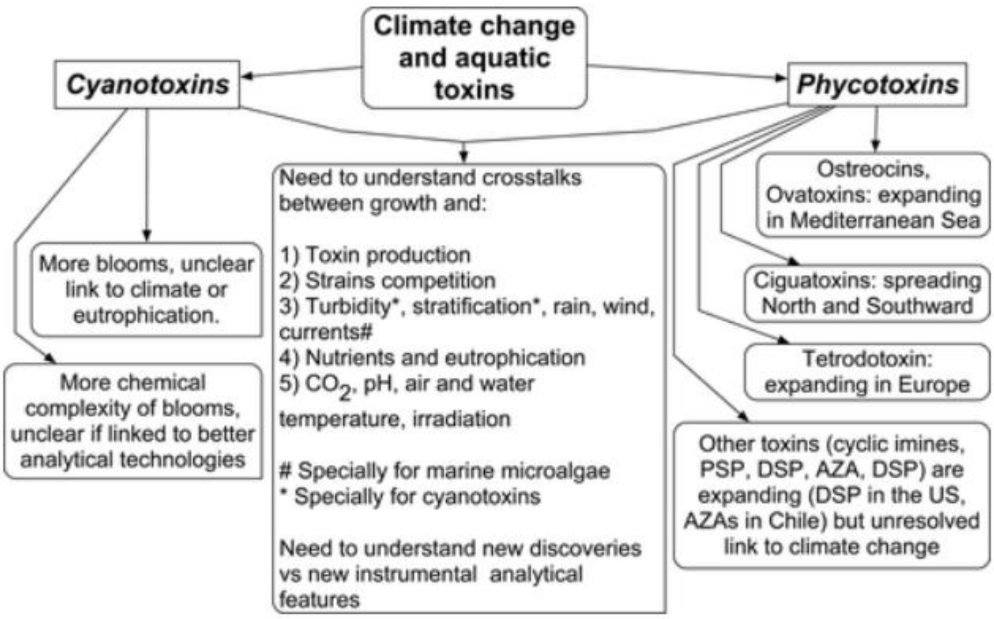

Figure 5: Influence of Climate Change on Aquatic Toxins

7. Conclusion:

Industries emit a variety of pollutants into the atmosphere. Pollutants such as methane, mercury, and sulphate are examples of pollutants. North America is a major contributor to industrial pollution. The continent produces a large amount of methane, mercury, and sulphates. Methane is a common pollutant emitted during the storage and transportation of natural gas. It has a negative impact on the environment. Methane gas contributes to global warming, which is harmful to the environment. Some diseases worsen when exposed to a hazardous substance, while others are caused by exposure to chemicals. Waste disposal and management are global issues. Poor, outdated, and illegal urban and harmful waste disposal procedures harm local populations in nearly every country, including illegal transboundary trafficking originating primarily in developed countries. The burden of illnesses caused by waste-related exposures is increasing in middle-low income countries and is not being adequately addressed.

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