Environmental Entomology (Ent-703) Credit Hours 2(2-0)

Lecture # 5 Delivered by Dr.Hassan Yasoob

Topic- Physical and Chemical Characterization of Environmental Contaminants

Environmental contaminant is the introduction of harmful materials caused by pollutants into the environment. Pollutants are the various impurities that have found their way into the environment due to both human activity and natural causes thus leading to pollution. These chemical compounds are harmful to both life and the environment. The WordWeb dictionary defines pollutants as "*waste matter that contaminates the water, air or soil.*"

According to environmentalists and scientists, there are various types of pollutants, and are classified according to the type of pollution they cause – such as water, air, soil, noise and radioactive pollution. Others types include thermal, plastic, agricultural, and light pollution.

Types of Pollutants Present in the Environment

1. Chlorofluorocarbons (CFC)

These are gases that are very destructive to the protective ozone layer. CFCs are used in sprays, perfumes and other canned products including aerosols. Since they are lighter than air, they rise to the atmosphere where the ultraviolet light frees the chlorine.

If the chlorine gets in contact with the earth's protective ozone layer, it causes irreparable damage which leads to entry of cosmic rays that are carcinogenic to human beings and the deterioration of marine and terrestrial plant growth.

2. Lead

This is a dangerous toxin found across the world, in fact, in all states. The element readily dissolves in water and upon uptake leads to devastating health problems. It negates the work of body's enzymes thereby slowing down the normal functioning of the body. In addition to this, it is one of the causes of nervous breakdowns, for in large quantities, it ends up affecting the brain.

3. Methane

This is a major component of natural gas, the gaseous form of fossil fuel. In itself it is harmless to the environment. However, it is one of the greenhouse gases and when it reacts with carbon dioxide in the presence of water vapor, it absorbs and retains most of the radiation heat from the sun. This traps excessive heat in the atmosphere contributing to global warming and climate change.

4. Carbon monoxide

This is one of the most lethal pollutants of the air. It is produced in various instances like cigarette smoking and whenever there is incomplete combustion. For vehicles to run, for example, the fuel in them has to undergo combustion to move the pistons that power the engine. The same applies to various machinery fuel powered equipment in industries.

But since the space within the engine is compacted and at times do not allow in enough oxygen for complete combustion, the fuels composed of a high hydrocarbon concentrations do not fully combust, releasing carbon monoxide as a byproduct.

Carbon monoxide clogs the air making it hard to breathe. It is also one of the leading causes of deaths associated with suffocation in homes where firewood is used in enclosed spaces. Carbon monoxide also plays a huge role in the formation of ground-level ozone.

5. Particulate matter (PM)

These are the very small particles suspended in the air. They can either be in solid form or in liquid form in both organ and inorganic particles. They are released into the atmosphere due to incomplete combustion like the carbon particles or blown into the air by wind. Examples are pollen, dust, soot, and aerosol spray liquid droplets just to mention a few.

They are very tiny and can, therefore, be easily inhaled. They cause respiratory problems such as lung cancer and are even more harmful to sensitive people especially those who suffer from asthma attacks.

6. Nitrogen oxides

There are many types of nitrogen oxides, most of which are harmful to the environment. These include; nitric oxide, nitrogen dioxide, nitrogen monoxide, and nitrogen pentoxide. The formation of these oxides happens in the atmosphere where nitrogen readily combines with oxygen at high temperatures.

Nitrogen dioxide has an irritating odor that also contaminates the air. Like sulfur dioxide, nitrogen dioxide combines with oxygen and water to form acid rain in the form of nitric acid thus leading to premature death, health complications, and corrosion of roofs.

7. Sulfur dioxide

This is the main ingredient of acid rain, which results in the corrosion of roofs and various health complications. The acid rain, weak sulfuric acid, is formed when there is oxidation of this compound. The process takes place when sulfur dioxide reacts with oxygen and other chemical oxides, and together with the water rain, it becomes acid rain.

8. Plastic

This is one of the most common environmental pollutants and bears one of the greatest impacts. The abundance of plastics in the world even led to the coining of the term “plastic pollution.” Plastic is used almost everywhere; to hold and package things such as foods, drinks, chemicals, and is also used as a raw materials

for making various products. More than 60% of all products are made using plastic.

To make matters worse, almost all single use items are made of plastics, which end up being thrown away after use. These plastics end up filling landfills, waterways, oceans, rivers and streams thus contaminating drinking water and water for domestic use. These same plastics find way into game parks and marine habitats harming wildlife and marine animals that confuse them for food.

9. Mercury

This element is released into the environment due to mining activities, poor disposal of certain items that are either made of mercury or had mercury in them. Batteries are a main source of mercury, which is why it is essential to dispose of them carefully. Mercury should be handled with care since it can readily change its state. This makes the element hard to detect and thus, hazardous. Inhalation of mercury can cause death.

10. Ground level ozone

This is one of the constituents of the well-known ozone, but the difference is that it forms just above the earth's surface. It is a highly irritating and colorless gas produced when there is a photochemical reaction between volatile organic compounds (VOCs) and nitrogen oxides in sunlight's presence.

Hence, it is referred to as secondary pollutant. Exposure to ozone is associated with pre-mature death, asthma, and respiratory problems in humans. It also decreases the yield of some crops and can destroy synthetic, textile, and cotton materials, and accelerates the corrosion of some coating/paints.

11. Bad smells

Odors are an irritation to human life and animals, and lead to the pollution of the environment.

12. Nitrates

Nitrates are a complex form of nitrogen and oxygen elements. The compound is associated with nitrate pollution, which causes water contamination from excessive

amounts of nitrates washed out from food and animal waste as well as inorganic fertilizers. Once in excessive concentration in water bodies, it causes **eutrophication** – a contributing factor to the contamination of waterways and death of aquatic life.

13. Phosphorus

Like nitrates, phosphorus is associate with nutrient pollution that lead to eutrophication and harmful algal bloom.

14. Automobiles

Motor vehicles are also pollutants considering the multiple pollutants they release into the environment. Without automobiles, some pollutants such as soot, nitrogen oxides, and hydrocarbons can be considerably cut back from the environment. But due to the use of fossil fuels in automobiles, there will always be the continuous release of carbon compounds and particulate matter into the atmosphere leading to air pollution. The hooting, alarms, and high rev sounds are also noise pollutants.

15. Loud sounds

Loud sound is a pollutant because it contributes to noise or sound pollution. The sources of the pollutant include vehicles, planes, clubs, and loud speaker radio systems. The music that is played in clubs is so loud that concentration is impossible a distance away from the place. Loud sounds cause temporal or permanent hearing impairments, and can also interfere with both the behaviors of humans and animals such as sleep, mating, movement and breeding.

16. Uranium

This metal is associated with radioactive pollution because it is highly radioactive. Exposure for humans can cause various cancers, premature aging, premature death, fertility problems, and interfere with the normal brain functions.

17. Volatile organic compounds (VOCs)

These are compounds that can easily become gas or vapor. They are mostly released from the burning of gasoline, wood, natural gas and coal. Other sources of VOCs include thinners and paints, cigarettes, solvents, wood preservatives, air

fresheners, furnishings, copy machines and printers, cleaners, pesticides, and disinfectants. VOCs react with nitrogen oxides in the atmosphere to form ground level ozone and smog.

18. PCBs (polychlorinated biphenyl)

This is an organic chlorine compound that was at one point extensively used as coolant fluids and dielectric in electrical gadgets, in heat transfer fluids, and in carbonless copy paper. It was banned in the US in 1979, but is still in use. PCBs are very dangerous pollutants since the chemicals are cancer causing and can adversely affect the life of fish and wild animals.

Chemical Properties, Environmental Fate, and Degradation of Seven Classes of Pollutants

Industrialism has brought a long series of benefits for modern civilization. Concomitantly, reversible and irreversible changes have been inflicted upon the environment, affecting humans, animals, and whole ecosystems and leading to effects such as declining reproduction in modern human beings, developmental challenges on various species, and destroyed habitats and ecosystems across the globe. In this context, a vast repertoire of modern and older literature is reviewed for a series of pollutants and their status as of 2014. The compound classes covered in this review are polychlorinated biphenyls, halogenated hydrocarbons, estrogen analogues, phthalates, dioxins, perfluorinated compounds, and brominated flame retardants. These groups represent ubiquitous pollutants, of which some have circulated in the environment for more than 60 years. In this context, this review describes the chemical properties, the environmental fate, and the toxicological effects of these classes of pollutants on humans and animals, including an introductory section on the detoxification systems that are triggered in most species upon intoxication. This combined review of *in vivo* transformation, chemistry, toxicological properties, and structure–activity relationships of pollutants aids in the understanding of the fate, biomagnification, bioaccumulation, and transformation of these compounds, which is essential for toxicologists, environmental scientists, and environmental legislators. The review is concluded with an outlook.

The toxicology of climate change: environmental contaminants in a warming world (A Review)

Climate change induced by anthropogenic warming of the earth's atmosphere is a daunting problem. This review examines one of the consequences of climate change that has only recently attracted attention: namely, the effects of climate change on the environmental distribution and toxicity of chemical pollutants. A review was undertaken of the scientific literature (original research articles, reviews, government and intergovernmental reports) focusing on the interactions of toxicants with the environmental parameters, temperature, precipitation, and salinity, as altered by climate change. Three broad classes of chemical toxicants of global significance were the focus: air pollutants, persistent organic pollutants (POPs), including some organochlorine pesticides, and other classes of pesticides. Generally, increases in temperature will enhance the toxicity of contaminants and increase concentrations of tropospheric ozone regionally, but will also likely increase rates of chemical degradation. While further research is needed, climate change coupled with air pollutant exposures may have potentially serious adverse consequences for human health in urban and polluted regions. Climate change producing alterations in: food webs, lipid dynamics, ice and snow melt, and organic carbon cycling could result in increased POP levels in water, soil, and biota. There is also compelling evidence that increasing temperatures could be deleterious to pollutant-exposed wildlife. For example, elevated water temperatures may alter the biotransformation of contaminants to more bioactive metabolites and impair homeostasis. The complex interactions between climate change and pollutants may be particularly problematic for species living at the edge of their physiological tolerance range where acclimation capacity may be limited. In addition to temperature increases, regional precipitation patterns are projected to be altered with climate change. Regions subject to decreases in precipitation may experience enhanced volatilization of POPs and pesticides to the atmosphere. Reduced precipitation will also increase air pollution in urbanized regions resulting in negative health effects, which may be exacerbated by temperature increases. Regions subject to increased precipitation will have lower levels of air pollution, but will likely experience enhanced surface deposition of

airborne POPs and increased run-off of pesticides. Moreover, increases in the intensity and frequency of storm events linked to climate change could lead to more severe episodes of chemical contamination of water bodies and surrounding watersheds. Changes in salinity may affect aquatic organisms as an independent stressor as well as by altering the bioavailability and in some instances increasing the toxicity of chemicals. A paramount issue will be to identify species and populations especially vulnerable to climate–pollutant interactions, in the context of the many other physical, chemical, and biological stressors that will be altered with climate change. Moreover, it will be important to predict tipping points that might trigger or accelerate synergistic interactions between climate change and contaminant exposures.