INTERNATIONAL RESEARCHERS

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Volume No.2 Issue No.2 June 2013

www.iresearcher.org

ISSN 227-7471

THE INTERNATIONAL RESEARCH JOURNAL “INTERNATIONAL RESEACHERS”

www.iresearcher.org

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Depletion of Stratospheric Ozone Layer: A Major Concern on Environmental and Agricultural Production in the 21st Century.

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Abstracts:

This study focuses on depletion of stratospheric ozone layer and its implications on environment and agricultural food production. Ozone is a gas made up of three oxygen atoms (o_2) which occurs naturally in small (trace) amounts in the upper atmosphere and protects life on Earth surface from the sun's ultraviolet (UV) radiation. It is created by chemical reactions between air pollutants from vehicle exhausts, gasoline vapour and other emissions. Although ozone high up in the stratosphere provides a shield to protect life on earth but direct contact with ozone is harmful to both plants and animals including humans. When the ozone is depleted, harmful substances are released to the atmosphere which leads to many health hazards like skin cancer, damages to plants and plankton as well as cataracts. The impacts on Environment and Agriculture particularly on human health, plants and animals, marine ecosystems and biogeochemical cycles are enormous and are examined in this study. This study identifies some of the key environmental and agricultural concerns of its depletion as well as possible methods of reducing depletion of ozone layer such as use of eco-friendly household products and stringent regulations on the use nitrous oxide, CFCs among others.

1. Introduction:

Recent debate worldwide has centered on Ozone depletion and its effects on the environment. The type of environment will to an extent dictate the type of agricultural systems that will be done in the area. Agriculture has played key role in the development of human civilization. Agriculture is the pivot of development of any nation especially the developing countries of African. Until the industrial revolution, the vast majority of the human populations were involved in crops and animals husbandry which has played and still playing key role in human food security. Agriculture constitutes the most important sector of the economics of sub-Sahara Africa countries. Unfortunately sub-Sahara Africa seems to be the only developing region in the world where food insecurity has worsened instead of being improved in the recent decades. This has led to mal-nourished individuals especially children below five years in the sub-Sahara Africa.

This ugly situation is believed to have been resulted from the continued destruction of ozone layer and its attendance climate change and global warming with its negative effects on environment and agricultural production. The human activities are mainly controlled by changes in the atmosphere such as rainfall, temperature, draught, e.t.c., especially regarding Agricultural food production. Since human survival depend entirely on availability of agricultural produce (food) and the availability is governed by these environmental changes, it is therefore pertinent that society must begin to think seriously toward the effects of the changes(ozone depletion) and to proffer strategies to overcome the dangers posed by these phenomena, if the developing nation must achieve the vision for food sufficiency in the near future.

The basic physical and chemical process that leads the formation of an ozone layer in the earth's stratosphere were discovered by Sydney Chapman in 1930.Ozone is a gas made up of three oxygen atoms (O_3). It occurs naturally in small (trace) amounts in the upper atmosphere (the stratosphere). Ozone protects life on Earth from the Sun's ultraviolet (UV) radiation. In the lower atmosphere (the troposphere) near the Earth's surface, ozone is created by chemical reactions between air pollutants from vehicle exhaust, gasoline vapours, and other emissions. At ground level, high concentrations of ozone are toxic to people and plants.

Ninety percent of the ozone in the atmosphere sits in the stratosphere, the layer of atmosphere between about 10 and 50 kilometers altitude (Kuo-Nan Liou 2002). The natural level of ozone in the stratosphere is a result of a

balance between sunlight that creates ozone and chemical reactions that destroy it. Ozone is created when the kind of oxygen we breathe—O_2—is split apart by sunlight into single oxygen atoms. Single oxygen atoms can re-join to make O_2, or they can join with O_2 molecules to make ozone (O_3). Ozone is destroyed when it reacts with molecules containing nitrogen, hydrogen, chlorine, or bromine. Some of the molecules that destroy ozone occur naturally, but people have created others.

The total mass of ozone in the atmosphere is about 3 billion metric tons(NASA report,2009).That may seem like a lot, but it is only 0.00006 percent of the atmosphere. The peak concentration of ozone occurs at an altitude of roughly 32 kilometers (20 miles) above the surface of the Earth. At that altitude, ozone concentration can be as high as 15 parts per million (0.0015 percent). The concentration of ozone varies with altitude. Peak concentrations, an average of 8 molecules of ozone per million molecules in the atmosphere, occur between an altitude of 30 and 35 kilometers.

Ozone in the stratosphere absorbs most of the ultraviolet radiation from the Sun. Without ozone, the Sun's intense UV radiation would sterilize the Earth's surface. Ozone screens all of the most energetic, UV-c, radiation, and most of the UV-b radiation. Ozone only screens about half of the UV-a radiation. Excessive UV-b and UV-a radiation can cause sunburn and can lead to skin cancer and eye damage

Solar ultraviolet radiation is largely absorbed by the ozone in the atmosphere—especially the harmful, high-energy UV-a and UV-b. Increased levels of human-produced gases such as CFCs (chlorofluorocarbons) have led to increased rates of ozone destruction, upsetting the natural balance of ozone and leading to reduced stratospheric ozone levels. These reduced ozone levels have increased the amount of harmful ultraviolet radiation reaching the Earth's surface. When scientists talk about the ozone hole, they are talking about the destruction of stratospheric, "good," ozone. In the context of this paper, the researchers are concentrating on the effects of damages made on stratospheric ozone layer.

Although ozone high up in the stratosphere provides a shield to protect life on Earth, direct contact with ozone is harmful to both plants and animals (including humans). Ground-level, "bad," ozone forms when nitrogen oxide gases from vehicle and industrial emissions react with volatile organic compounds (carbon-containing chemicals that evaporate easily into the air, such as paint thinners). In the troposphere near the Earth's surface, the natural concentration of ozone is about 10 parts per billion (0.00001 percent). According to the Environmental Protection Agency, exposure to ozone levels of greater than 80 parts per billion for 8 hours or longer is unhealthy. Such concentrations occur in or near cities during periods where the atmosphere is warm and stable. The harmful effects can include throat and lung irritation or aggravation of asthma or emphysema (NASA report,2009)

2. Causes of Ozone Depletion

The depletion of the ozone layer is a phenomena that was observed during the later part of the 70s and has since then showed a declining rate of 4% per decade and there is a remarkable decrease over the polar regions of the Earth. The main reason for the destruction of the ozone is by man-made halocarbon refrigerants such as CFCs, halons and freons that are released into the atmosphere and are known as 'ozone depleting substances' or ODS. These harmful substances strike the ozone and splits it apart. The ozone depletion has led to a worldwide concern as the thinning protective coat over Earth is letting harmful ultraviolet light pass which has led to many health hazards like skin cancer, damages to plants and plankton as well as cataracts. Therefore many governments have banned products that produce these ODS.

3. Environmental and Agricultural Effects of Ozone Layer Depletion

3.1 The Connection between Ozone Layer Depletion and UVB Radiation:

Reductions in stratospheric ozone levels will lead to higher levels of UVB reaching the Earth's surface. The sun's output of UVB does not change; rather, less ozone means less protection, and hence more UVB reaches the Earth. Studies have shown that in the Antarctic, the amount of UVB measured at the surface can double during the annual ozone hole. Another study confirmed the relationship between reduced ozone and increased UVB levels in Canada. (3)

3.2 Effects on Human Health

Laboratory and epidemiological studies demonstrate that UVB causes nonmelanoma skin cancer and plays a major role in malignant melanoma development. In addition, UVB has been linked to cataracts -- a clouding of the eye's lens. All sunlight contains some UVB, even with normal stratospheric ozone levels. It is always important to protect your skin and eyes from the sun. Ozone layer depletion increases the amount of UVB and the risk of health effects (5).

EPA uses the Atmospheric and Health Effects Framework (AHEF) model, developed in the mid 1980s, to estimate the health benefits of stronger ozone layer protection policies under the Montreal Protocol. EPA estimates avoided skin cancer cases, skin cancer deaths, and cataract cases in the United States(4).

3.3 Effects on Plants and Animals:

Physiological and developmental processes of plants are affected by UVB radiation, even by the amount of UVB in present-day sunlight. Despite mechanisms to reduce or repair these effects and a limited ability to adapt to increased levels of UVB, plant growth can be directly affected by UVB radiation.

Indirect changes caused by UVB (such as changes in plant form, how nutrients are distributed within the plant, timing of developmental phases and secondary metabolism) may be equally, or sometimes more, important than damaging effects of UVB. These changes can have important implications for plant competitive balance, herbivore, plant diseases, and biogeochemical cycles. The increase in carbon dioxide is the major contributor to climate change. Carbon dioxide concentrations are increasing in the atmosphere primarily as the result of the burning of coal, oil, and natural gas for energy and transportation. The atmospheric abundance of carbon dioxide is currently about 30% above what it was 150 years ago (6).

There is an additional factor that indirectly links ozone depletion to climate change; namely, many of the same gases that are causing ozone depletion are also contributing to climate change. These gases, such as the chlorofluorocarbons (CFCs), are greenhouse gases, absorbing some of the infrared radiation emitted by the Earth's surface, thereby effectively heating the Earth's surface. Climate change can affect organisms and their habitats In a myriad of ways. In fact, Global warming impacts all life on earth, from individual organisms to populations, species, communities, and ecosystem. How strongly different species will be affected varies, depending on differences in their ecology and life history. Species with small population sizes, restricted ranges, and limited ability to move to different habitats will be most affected. Similarly, different habitats and ecosystem will be impacte differently, with those in coastal, high latitude, and high altitude regions most vulnerable.

The impacts can be noticeable on wildlife on a number of ways including: reproduction timing, migration timing and patterns, frequency and intensity of pest out breaks and extinction in vulnerable species.

3.4 Effects on Marine Ecosystems

The greatest impacts of ozone layer depletion are on the oceans. As the effects of carbon raise earth's average temperature, the polar icecaps melt and the seas rise, as the seas rise, fish lose their habitat. Reefs that once rested in water shallow enough to receive sunrays to support their living creatures' falls into darkness and die. The rising seas also block photosynthesizing rays of light to local sea grasses and kill them. The reefs and sea grasses are important nurseries for sea life such as shrimp, zooplankton, and numerous fish species.

The rising earth temperature also increase the level of heat in the ocean itself .As the oceans' temperature rise, carbon dioxide is trapped in the water and raises the pH level of the sea. The increase acidity of the ocean can harm fish and the vital zooplankton that all sea creatures rely on for a healthy food chain. Sadly, the ocean is not our only concern. Land creatures are even other attack by ozone layer depletion.

Phytoplankton form the foundation of aquatic food webs. Phytoplankton productivity is limited to the euphotic zone, the upper layer of the water column in which there is sufficient sunlight to support net productivity. The position of the organisms in the euphotic zone is influenced by the action of wind and waves. In addition, many phytoplankton are capable of active movements that enhance their productivity and, therefore, their survival. Exposure to solar UVB

radiation has been shown to affect both orientation mechanisms and motility in phytoplankton, resulting in reduced survival rates for these organisms. Scientists have demonstrated a direct reduction in phytoplankton production due to ozone depletion-related increases in UVB. One study has indicated a 6-12% reduction in the marginal ice zone(7).

Solar UVB radiation has been found to cause damage to early developmental stages of fish, shrimp, crab, amphibians and other animals. The most severe effects are decreased reproductive capacity and impaired larval development. Even at current levels, solar UVB radiation is a limiting factor, and small increases in UVB exposure could result in significant reduction in the size of the population of animals that eat these smaller creatures.

3.5 Effects on Biogeochemical Cycles

Increases in solar UV radiation could affect terrestrial and aquatic biogeochemical cycles, thus altering both sources and sinks of greenhouse and chemically-important trace gases e.g., carbon dioxide (CO2), carbon monoxide (CO), carbonyl sulfide (COS) and possibly other gases, including ozone. These potential changes would contribute to biosphere-atmosphere feedbacks that attenuate or reinforce the atmospheric buildup of these gases.

4. Methods of reducing or managing ozone depletion

The ozone layer is our warrior against the mighty Sun that is bombarding earth with harmful UV radiation and we are trying our best to protect it. Ozone is basically a gas also referred to as O3 which is formed and reformed constantly in our Earth's atmosphere. If it were not for the ozone layer, our Earth would be barren with slight traces of life. It is also being said that the southern hemisphere of the Earth could have an additional 20% depletion of the ozone that could result in natural calamities like tornadoes, avalanches, fires, tsunamis etc. Here are some methods we can adopt to protect the ozone layer and our precious Earth:

4.1 Limit private vehicle driving / Gaseous emitting machines

A very easy way to control ozone depletion would be to limit or reduce the amount of driving as vehicular emissions eventually result in smog which is a culprit in the deterioration of the ozone layer. Car pooling, taking public transport, walking, using a bicycle would limit the usage of individual transportation. It would be a great option to switch to cars/vehicles that have a hybrid or electric zero-emission engine. Also important is the reduction in the use of both domestic and industrial generators that emit ODS into the atmosphere. This could be achieved by increasing the megawatts of electricity generation and distribution, and making it assessable and affordable consumers

4.2 Use eco-friendly household cleaning products

Usage of eco-friendly and natural cleaning products for household chores is a great way to prevent ozone depletion. This is because many of these cleaning agents contain toxic chemicals that interfere with the ozone layer. A lot of supermarkets and health stores sell cleaning products that are toxic-free and made out of natural ingredients.

4.3 Avoid indiscriminate use of Pesticides and Herbicides

Pesticides and Herbicides may be an easy solution for getting rid of pests and weeds, but are harmful for the ozone layer. The best solution for this would be to try using natural remedies, rather than heading out for pesticides. You can perhaps try to weed manually or mow your garden consistently so as to avoid weed-growth.

4.4 Stringent laws regulating rocket launching should be put in place

The world is progressing in scientific discoveries by leaps and bounds. A lot of rocket launches are happening the world over without consideration of the fact that it can damage the ozone layer if it is not regulated soon. A study shows that the harm caused by rocket launches would outpace the harm caused due to CFCs (3). At present, the global rocket launches do not contribute hugely to ozone layer depletion, but over the course of time, due to the advancement of the space industry, it will become a major contributor to ozone depletion. All types of rocket engines result in combustion by products that are ozone-destroying compounds that are expelled directly in the middle and upper stratosphere layer – near the ozone layer.

4.5 Legislative control on the use of dangerous nitrous oxide

Due to the worldwide alarm caused by a study in the late 70s about the alarming rate at which the ozone was being depleted, nations around the globe got together and formed the Montreal Protocol in the year 1989 with a strong aim to stop the usage of CFCs. However, the protocol did not include nitrous oxide which is the most fatal chemical that can destroy the ozone layer and is still in use. Governments across the world should take a strong stand for banning the use of this harmful compound to save the ozone layer.

4.6 Use of Organic farming

Organic farming is the production system which avoids or largely excludes the use of synthetic fertilizers, pesticides, growth regulator and livestock feed additives. The system relied upon crop rotation, crop residue, animal manure, legumes, green manure, off-farm organic wastes, mechanical cultivation, mineral bearing rocks and aspect of biological pests control to maintain soil productivity to supply plant nutrients and control insects, weeds and other aspect (8). The organic farming is sustainable and environmental friendly, because its withstand severe weather conditions, mitigate and reverses the effects of climate change while reducing nitrate leaching (9).

5. Conclusion:

Stratospheric ozone layer is the natural shield that protects the earth's surface from the deadly ultraviolet radiation. This is achieved by reducing the quantity of UV-radiation that would have penetrated to earth surface. The result of depletion of ozone layer include effects on: human health, plants, marine, ecosystem among others. The production and use of oxides of nitrogen,CFCs and other ODS need to be effectively controlled in order to ensure healthy and safety environment, this will in turn boost agricultural production, raise the standard of living and eradicate poverty.

References

1. Kuo-Nan Liou (2002) An Introduction to Atmospheric Radiation. Academic Press.
2. NASA report,18 Nov.,2009, www.ozonewatch.gsfc.nasa.gov/facts/hole.html
3. Prem (2011),ways to prevent ozone depletion.www.greendiary.com
4. Enviromental Effects of ozone depletion and its interactions with climate change:EPA Report 2010 pp68 : www.ozonewatch.gsfc.nasa.gov/facts/hole.html
5. AHEF (2006)Peer-reviewed report on Analytical and Empirical Methodologies by Atmospheric and Health Effect Framework
6. Environmental Effects of Ozone Depletion and its interactions with climate change,2010 Monyreal protocol Assessment report.
7. EPA (2011) Health and Environmental effects of ozone depletion:www.epa.gov/ozone/science/effects
8. Oluwatobi (2010): Organic Farming,African Newspaper of Nigeria,PLC,Vol.3,pp22-25
9. IFOAM,2011 :www.ifoam_orgorganicon.