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Current Issues in Environmental Physics

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Abstract

Environmental Physics is concerned with our environment and the forces/interactions that influence it. Among the things that influence our environment is environmental pollution. The result of a mathematical modeling of the transient effects of pollutant shows that, the pollutant concentration in the air decreases with time, assuming all pollution sources were cut off. Since in real life situation, source/sources of pollution is/are always available, it becomes necessary to find ways of reducing environmental pollution. In line with this, governments of various nations of the world have enacted rules geared towards checking emissions. At the international level, emission control is being championed by the United Nations. Environmental pollution leads to climate change; and climate change has its own challenges some of which include: rise in global sea level, increase in diseases among the populace, change in ecosystem, etc. A call was made in this paper for all and sundry to join in the campaign against environmental pollution and its consequent climate change.

Keywords: Environment, Physics, Pollution, Climate, change

1.0 Introduction

Gradually, concern with local, national and global environment has grown and the consequences of many environmental issues can no longer be ignored. The concerns of local environmental groups have coalesced into global commitments and these have become a conspicuous part of the national and international political agendas (Mason et al., 2001). There has been an undeniable growth in environmental consciousness and the implications of climate change to the future generation. At the international level, action is being taken to safeguard our environment. International concerns with climate change has made both politicians and the general public much more aware of the impact of local and global weather in all aspects of domestic life, industry and commerce. A wide spread sense of environmental crises and the problems that generate them present a great challenge. As a science, Environmental Physics tends to address these problems (Pickering and Owen, 1997).

It is also concerned with our environment and the things that influence it. According to Boeker and Grondelle (1995), the essentials of environmental physics include: Elementary (environmental) spectroscopy, the global climate, energy for human use, transport of pollutants, and noise. Environmental Physics is concerned with providing solutions to environmental problems, and being a science, it has formulated the means to predict and facilitate the transformation of our world. From the biological point of view, it concerns the description and analysis of physical processes that establish the conditions in which all species of life survive and reproduce (Mason et al., 2001). It involves a synthesis of mathematical relations that describe the physical nature of the environment and the many biological responses that environments evoke (Monteith and Unsworth, 2008). Environmental Physics provides a basis for understanding the complex responses of plants and animals to environmental change. The concept has become more widely used by biologists, atmospheric scientists and climate modelers to specify interactions between surfaces and the atmosphere. Through measurements, monitoring and analysis, and by reducing the uncertainty in modeling, environmental Physics provides an understanding of environmental processes, especially where global environment change is concerned. It is therefore is a branch of Physics worth paying attention to.

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Now the question is: what are the current issues in environmental Physics? The current issues in environmental physics are: pollution problems and climate change.

2.0 Pollution Problems

One of the major problems of our environment today is pollution. Pollution is the introduction of contaminants into a natural environment that causes instability, disorder, harm or discomfort to the ecosystem (Encarta, 2009). Such contaminants could be in the form of particles or chemicals.

We have air pollution due to release of carbon monoxide from exhaust pipe of cars, heavy duty machines and generating plants (Pal and Khan, 1990). Air pollution is a common thing in Nigeria today and the world at large (See Figure 1). For example in Nigeria, out of the ten (approximate) power stations available, seven are using petroleum products for power generation (Okoro et al., 2007). These petroleum products are used up by some combustion processes (ASTM D240, 2009). The smoke from these power plants constitutes air pollution. Air pollution is the introduction into the atmosphere of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environmentor built environment.

The atmosphere is a complex dynamic natural gaseous system that is essential to support life on planet Earth. Stratospheric ozone depletion due to air pollution has long been recognized as a threat to human health as well as to the Earth's ecosystems. Indoor air pollution and urban air quality are listed as two of the world's worst pollution problems in the 2008 Blacksmith Institute World's Worst Polluted Places report. A substance in the air that can cause harm to humans and the environment is known as an air pollutant. Pollutants can be in the form of solid particles, liquid droplets, or gases. In addition, they may be natural or man-made. The 2010 World' s Worst Pollution Problems Report identifies the Top Six pollutants that posses a great treat to the human race (Fuller, 2011). They include: lead, mercury, chromium, Arsenic, pesticides, and radionuclides. The report describes the scope and health impacts of each pollutant. The report is the fifth in a series of annual pollution reports released by Blacksmith Institute and Green Cross, Switzerland. We also have other forms of pollution (apart from air pollution). They include: noise pollution, light pollution, water pollution, soil pollution, radioactive pollution, thermal pollution and visual pollution.

2.1 Noise Pollution

This is pollution resulting due to excessive sound. Noise, according to Akpan and Onuu (2004) is an undesirable sound. They went ahead to explain that although a sound may be undesirable by a person, to another person that undesirable sound may be desirable. So it can be concluded that what is desirable and undesirable depends on individuals. Thus noise can be properly defined as a sound with no periodicity. Noise pollution encompasses roadway noise, aircraft noise, industrial noise as well as high-intensity sonar. Noise pollution has caused people who could not bear it to commit suicide. "One person who killed himself in a certain country left an inscription written: Oh noise! Oh noise, I cannot bear you anymore" (Emttoni, 2003)!

2.2 Light Pollution

This results due to excessive release of light to the environment by any source of light. Light pollution includes light trespass, over-illumination and astronomical interference. Laser light could constitute pollution, particularly when it is not controlled (Koch et al., 1993). Light from laser are usually intense and can cause damage to the eye if exposed to it.

2.3 Water Pollution

This results due to release of waste products and contaminants into rivers, ponds, seas and oceans through drainage systems (See Figure 2). Other forms of water pollution could come through leaching into groundwater, liquid spills (Beychok, 1967), wastewater discharges, littering and eutrophication (This is the process by which a body of water becomes rich in dissolved nutrients from fertilizers or sewage, thereby encouraging the growth and decomposition of oxygen-depleting plant life and resulting in harm to other organisms).

2.4 Soil pollution

Occurs when chemicals are released by spill or underground leakage into the soil. Among the most significant soil contaminants are hydrocarbons, heavy metals, herbicides, pesticides, sand chlorinated hydrocarbons. Day by day, farm lands are being polluted by farmers through the use of herbicides and pesticides (Cull et al., 2000).

2.5 Radioactive pollution

Results from 20th century activities in atomic physics, such as nuclear power generation and nuclear weapons research, manufacture and deployment. The recent radioactive pollution in Japan resulted due the fukushima nuclear accident following the earth quake in that country (IAEA, 2011).

2.6 Thermal pollution

This is a kind of pollution that results due to increase in temperature of natural water bodies caused by human activities, such as use of water as coolant in a power plant (Pseud, 2011).

Generally, pollution causes hazards to our environment (Makinde and Chinyoka, 2010). If the problem is not carefully controlled and monitored, large communities can be exposed to extensive health risks. Early detection of such pollution accidents, both in terms of extent and impact, is thus of major primary importance, and the subsequent requirement to take immediate corrective measure to redress the pollution problem and mitigate against its impact is equally inportant. Spread of pollutants in a fluid flow depends largely on concentration coefficients (Taylor, 1954)

3.0 Mathematical Modelling of Transient Effect of Pollutants

This modeling was done my Makinde (2011) and delivered in a workshop on Mathematical modeling using maple and matlab, at covenant University, Ota. The programme is given below:

Model problem in Environmental Air pollution
Model equation: diff(C(x,t),t)+U*diff(C(x,t),x)=diff(C(x,t),x$2)/Sc+F1
Initial and boundary conditions C(x,0)=fx,D[1](C)(0,t)=0 C(10,t)=0

Figure 1: Air pollution (Air pollution from World War II weapon production in Alabama)

Figure 2: Water pollution (The Lachine Canal in Montreal Canada, is polluted).

C(c,t) represents pollutant concentration profiles

```
with(plots):
 Sc:=2.63:
 U:=1:
 fx:=1-exp(x^2-1):
 F1:=x^2*sin(Pi*t):
 fcns:=[C(x,t)]:
 IBC:=[C(x,0)=fx,D[1](C)(0,t)=0,C(1,t)=0]:
sys:=[diff(C(x,t),t)+U*diff(C(x,t),x)=diff(C(x,t),x$2)/
 Sc+F1]:
 pds:=pdsolve(sys,IBC,fcns,numeric):
 p1c:=pds:-plot(C(x,t),x=0,t=0..10,
 numpoints=50,labels=["t","Pollutant
Concentration"],style=line,color=black):p2c:=pds:-
  plot(C(x,t),x=0.4,t=0..10,numpoints=50,labels=
  ["t","pollutant
Concentration"],style=point,symbol=circle,color=black):
 p3c:=pds:plot(C(x,t),x=0.7,t=0..10,numpoints=50,
```

```
 labels=["t","pollutant
Concentration"],style=point,symbol=cross,color=black):
 p4c:=pds:plot(C(x,t),x=0.9,t=0..10,numpoints=50,
 labels=["t","pollutant
Concentration"],style=point,symbol=point,color=black):
 plots[display]({p1c,p2c,p3c,p4c});
```

3.1 Result of the Model

When the programme was run in Maple environment the result shown in Figure 3 was obtained which shows that pollutant concentration in the air seems to decrease as time increases. This is true because if we consider pollution due to smoke particles for example, we find out that when the source of the smoke is stopped, the smoke particles quickly disperse from the air after a short while. As time goes by, you may not find a trace of the smoke particle in the air. The above is the case when the source of the pollution has been cut off. In real life situations, it is easy to see sources of pollution in most urban and rural environment.

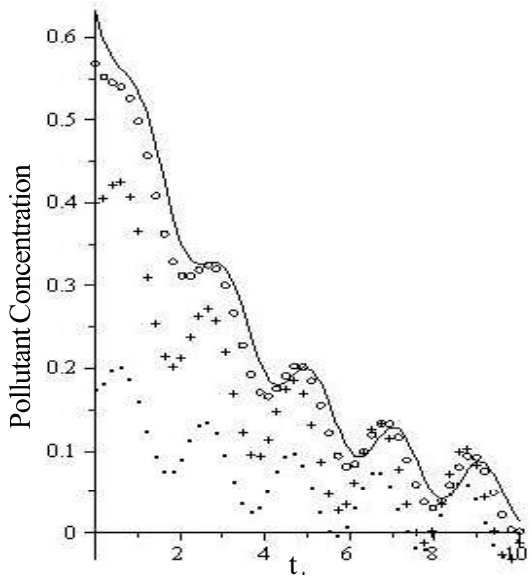

Figure 3: Graph of pollutant concentration (in mol/ cm^3) against time (in seconds).

To protect the environment from the adverse effects of pollution, many nations of the world have enacted legislation to regulate various types of pollution as well as to mitigate the adverse effects of pollution (Pseud, 2011). Recently in Nigeria, the Director General of the National Orientation Agency (Alhaji Idi Faruk) called for the ban on importation of polythene materials into the country (Albashiru, 2011). This is to forestall the adverse effect of littering pure water sachets all around our environment. Since pollution crosses political boundaries, international treaties have been made through the United Nations and its agencies to address international pollution issues. The Kyoto Protocol is an amendment to the United Nations Framework Convention on Climate Change (UNFCCC), an international treaty on global warming. The Kyoto protocol is expected to end in the year 2012 and would be replaced by an improved treaty.

In Canada the regulation of pollution and its effects are monitored by a number of organizations depending on the nature of the pollution and its location. The three levels of government (Federal - Canada Wide; Provincial; and Municipal) equally share in the responsibilities, and in the monitoring and control of pollution (Pseud, 2011). This is the case with other countries of the world. They all have one regulation or the other to check pollution. Now we proceed to the next current issue on environmental Physics. And that is climate change.

4.0 Climate Change

Climate change may be defined as the total variety of weather experienced in a place over some specified period of time, usually some decades. Climate is never static, but is constantly changing over several timescales. Important timescales for climate change include (Benn, 2011):

- geological changes over tens of millions of years, associated with tectonic movements
- glacial-interglacial cycles over 100,000s of thousands of years, associated with cyclic changes in the Earth's orbit (Milankovitch cycles)
- fluctuations within glacial or interglacial periods over 1,000s or 100's of years, possibly due to variations in solar output
- decadal changes
- inter-annual variability

Any climate change has the potential to disrupt human activities. The changing climate and its effect on all is becoming increasingly apparent - ozone depletion, hurricanes, floods and extreme weather behaviour. Since the Industrial Revolution, humans have been pumping out huge quantities of carbon dioxide, raising carbon dioxide concentrations by 30%. The burning of fossil fuels is partly responsible for this

huge increase, (this has been studied under air pollution). Over time, the amount of carbon dioxide in the air has been on the increase. Figure 4 shows the increase in the concentration of carbon dioxide from 1860 till 1990 (UKECN, 2011).

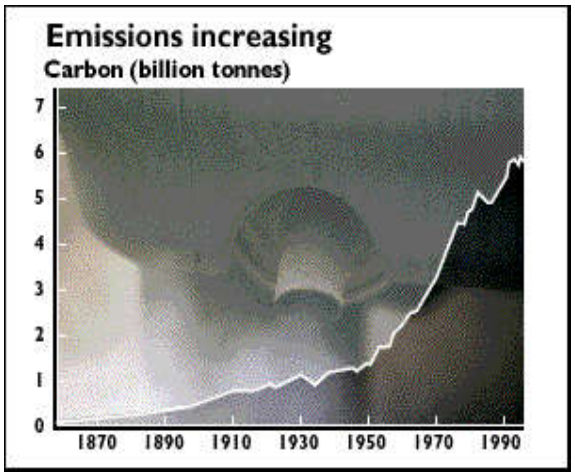

Figure 4: Increasing carbon dioxide emission since 1860 (source: Wikipedia).

There are some uncertainties as to what effects a change in climate might have on the earth. To predict what might happen, an understanding of how the increase in gases such as carbondioxide and methane occur and how they affect our climate is necessary. The rays from the Sun hit the earth and some are reflected back into space. However, gases in the atmosphere such as carbon dioxide and methane form a barrier for sunlight to leave the earth's atmosphere. The sun rays hit the earth, but when they are reflected back out into space, they are trapped in the atmosphere. The sun rays cannot escape from the earth's atmosphere, and the earth heats up. This is called the **'Greenhouse Effect'**.

In the recent interview with the UN Chief on climate change: Christiana Figueres, she has it that: "The world may have to resort to technology that sucks greenhouse gases from the air to stave off the worst effects of global warming" (Figueres, 2011). According to her: "We are putting ourselves in a scenario where we will have to develop more powerful technologies to capture emissions out of the atmosphere". "We are getting into very risky territory," she said, stressing that time was running out. This means that there is urgent need to embark on development of alternative energy sources that would be environmental friendly, in order to check greenhouse gas emissions.

The UN summit on climate change held between Monday 6th and 20th June, 2011 at Bonn, Germany. The next one would be in December 2011, in Durban, South Africa (according to Sunday 5th Guardian). The agenda of the summit is centered on climate and its consequences.

Humans have been vulnerable to changes in climate at least since the introduction of permanent settlements. Climate change affects the availability of water, communications, the length of the growing season, the wellbeing of livestock, and many other factors, and has been a decisive factor in the survival of communities throughout history. Below are some predictions of what might happen to the earth if continuously subjected to a change in climate.

- There would be a rise in global sea level.
- There would be an increase in disease level.
- There would a change in the ecosystem.
- And there would be a change in the vegetation zones.

4.1 Rise in Global Sea Level

One impact of climate change would be a rise in global sea levels (Park, 1997). If the heat from the sun cannot escape through the earth's atmosphere then the ice at the north and south poles could melt. This could have a huge effect on the low lying areas of the world. As at 1998, 46 million people live in areas at risk of flooding (UKECN , 2011). This amount could increase rapidly if sea levels rose. Scientists estimated that a sea rise of only 50 centimetres would increase the number of people at risk to 92 million. A sea level rise of 1 metre would put 118 million people at risk. Scientists believe that there will be a sea level rise of 50 centimetres over the next 40 to 100 years (UKECN, 2011).

4.2 Increase in Disease Level

It is believed that if the temperature increased by 3-5 degrees Celsius, the number of people potentially exposed to malaria (from mosquito) could increase from 45% to 60% of the world's population (McMichael, 1995). This could lead to an extra 50-80 million cases of malaria in a year (UKECN, 2011). The transmission rate of the disease could increase as the infected population migrate from one region of the world to the other (Mlyashimbi et al.,

2011).

4.3 Change in the Ecosystem

Ecosystems could be affected by a change in temperature. It has been predicted that an increase in temperature would affect species composition. Scientists also believe that up to two thirds of the world's forests would undergo major changes. Scientists believe that deserts would become hotter, and desertification would extend and become harder to reverse (UKECN, 2011).

4.4 Change in the Vegetation Zones

A change in climate would have an effect on the world's vegetation zones. There would be a change in the boundaries between grassland, forest and shrub land. This change in vegetation zones could cause famine in arid areas such as Africa that depends on a certain type of crop. The change in vegetation would cause mass movement of people away from arid regions. This could cause huge over-crowding in towns and cities (UKECN, 2011).

5.0 Conclusion

The very survival of our planet is at risk: human misuse of natural resources and the destruction of natural environmental systems are pushing the Earth to the limits of its capacity. There is need to stop pushing the earth to its limit. We can achieve this by trying to reduce to the barest minimum carbon dioxide emission. Carbon dioxide is said to have an effective lifetime of about 100 years. This means that any changes in the atmosphere will take a long time to develop. If we cut down on the amount of carbon dioxide we use, the rate of climate change will slow down.

One way we can cut down on the amount of carbon dioxide we use is by making less car journeys. Another way is by development and adoption of renewable energy sources in place of burning of fossil fuel for power generation. Some examples of renewable energy sources include: wind, Sun, hydro, etc. The sun replenishes itself by means of some nuclear reactions (Garlic, 2002). The beauty of the solar source of energy is that it is abundant and enormous amount of energy is obtained from it throughout the year (Basu and Antia, 2008).

According to Chen (2009) the power generated from the sun each year throughout the face of the earth is 120,000 terawatts. What this implies is that covering only 0.1% of the earth's surface with solar cells of 10% efficiency would satisfy our current energy need. Currently, the world consumes far less than 120,000 terawatt of energy annually (Chen, 2009). If this energy from the Sun is properly harnessed the world may not have need for fossil fuel any more. So the development of solar source of energy will mean well for our environment.

Reduction in green house gas emission is every one's business. This means that everyone has a stake in slowing down increase in global temperatures. Together we can save the future of our environment.

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