

## MATHEMATICAL MODELING - A TOOL FOR SOLVING ENVIRONMENTAL PROBLEMS

**Sam O. Ale<sup>1</sup>**

*The Director & Chief Executive  
National Mathematical Centre,  
Abuja, Nigeria*

The history of mankind is surrounded by various mishaps. In the last three decades, many catastrophes were recorded, some of which were natural ones and others due to failure or poor design of man-made equipment.

In 1979, there were three dangerous holocausts in the Three Mile Island, Pennsylvania. Aftermath was great record of cancers on workers at the plant. In Gujarat, India, there was a dam failure with 10,000 death recorded while in Nigeria, Ogunpa river at Ibadan over flew its bed and several hundreds people were estimated dead.

There were other catastrophes in the early Eightieth and twentieth centuries, few are summarized below:

Place	Year	Event	Consequence
North sea	1980	Rig capsize	123 death
Ixhuatepee , Mexico	1980	LPG explosions	500 death
Bhopal, India	1984	Toxic release (MIC)	2500 death
Chemobyl, USSR	1980	Nuclear reactor fire	31 death due to radiation sickness 160 extra cancer death recorded
Lake Victoria, Cameroon	-	Volcanic eruption	later Several thousand people died
Ikeja Cantonment, Nigeria	2003	Explosion	
New York, USA	2001	Bombardment	“ “ “ “

The list can go on and, without end. In Nigeria, there are several oil spillages, some of which triggered fire incidence in South East and Niger Delta regions of Nigeria and many lives lost.

In Nigeria also there were several reported cases of erosion and occasional invasion of farmland by pest in the last millennium. It is in view of how to arrest these natural and

---

<sup>1</sup> AMS subject classification: 92G, 92D

man-made environmental problems that the Centre is organizing the workshop on Mathematical Modeling of Environmental Problems.

The idea behind it is to pool together resources both human and financial on how to help the nation to train scientists who will be working on environmental problems and management using mathematical modeling as a working tool.

Let us first of all consider areas on Environmental problems where attention need be focused on:

### **Ecological Problem**

Ecology is all about the interaction of living organisms with the environment. The environment surrounding the organism includes both the living (biotic) and non-living (abiotic).

Every organism has both internal and external environments. The study of the organisms (autecology) or as a group (synecology) which could be in form of tribes, races, population, communities (fauna) or strains, varieties, associations, population communities (flora) etc.

Both the organism and their environment (or habitat) and the interactive organism and its habitat (ecology) can be connected, measured and analyzed (which is the role of mathematical modeling) when this is done 'in situ' we have empirical data conversely when there is an influence on the factors than the data then it is experimental data.

The need to evaluate the effect of human on the environment and to develop a control to minimize environmental degradation is increasingly becoming inevitable globally.

The environment is continuously disturbed intermittently by natural disasters like earth tremors, flood, earthquakes, desert encroachments and global warming. Moreover, the occasional invasion of farmland by quiller birds, locus, monkeys, elephants and cattle. The aftermath often result into serious incalculable loss of lives and properties.

Furthermore, man through his bye products has endangered (disturbed) his life and that of other living organisms (biomass) in the biosphere he lives. This is done through production of toxic products in form of gasoline, poisonous hydrocarbons, solvents, pesticides, insecticides, and emission of heavy metals like aluminum, lead and mercury. These heavy metals posses serious danger to peoples' health.

### **Environmental Diseases**

Change in the environment often cause changes in disease transmission. Change in human behaviour and vector transmission may cause increase in malaria incidence in a given habitat. Change in land use may mark change vector transmission, for example reforestation for watershed protection or plantation of commercial plants may make net economic rate of return, which result in the adverse health impacts.

Conversion of forest district into economic commercial tree crops, rubber plantation and orchard lead to higher incidence of malaria than ever.

### **Man-made Environmental Problems**

In Nigeria, there are serious natural and man made disasters such as overflowing of beaches, collapse of dams and lakes, flaring of gases leading to global warming and ‘entropy traps’, oil spillages and water erosions, outbreak of pests, animal encroachment on farmland and outbreak of diseases that are water and air borne.

Considering the low foreign reserve (<USD 300) and per capita income of Nigeria, prevention of ecological disasters is the most viable ecological management the country should adopt. The use of traditional ‘fire bridge’ approach in solving the ecological problems when happened cannot give a long lasting solution.

Ecological planning and management have been receiving global recognition of late. Many countries are devoting huge resources and energy on environmental impact assessment (EIA) programmes and even inculcate EIA studies in the national planning.

The problem and solution to environmental problem through the use of mathematical modeling of ecological problem is indispensable today. It is most vibrant tool for analyzing data and prediction of ecological phenomonal.

An American social philosopher Lewis Mumford, sixty-two years ago in his ‘Autograph Techniques and Civilization called for a humane technology and society that denied growth by limiting consumption’.

By Lewis’ philosophy, Nigeria needs a society with clean breathing air and clean safe drinking water, we need an environment devoid of polluted air emanating from flaring of hydrocarbon fuel, environment hazard orchestrated by bizarre unsolicited for ecological problems.

We need to have on ground; sustainable environmental protection policies, fire bridge approach cannot solve Nigerian ecological problems. It is in view of this the National Mathematical Centre (NMC) has brought together four highly prized professors to come and brainstorm on some key areas of Research on Environmental problems.

The resource persons are expected to use mathematical modeling technique in qualitative and quantitative ways to train the participants on how to solve at least one of the following problems:

1. Flood as a result of failure of dams, lakes, overflow of beaches.
2. Desert encroachment leading to population emigration.

3. Oil recovery and Flaring of gases that has been leading to global warming and entropy trap. Emission of excess carbon dioxide into the atmosphere as a result of burning of fossil fuel, thereby creating green house effect. Thus green house effect will cause a marked rise in temperature in the world. The world climatic change will have impact on agricultural production, human health and global ecology, including the possibility of substantial population migration.
4. Combustion of coal and combustible substances.
5. Marine ecosystems and marine resources.

### **Population and Environmental Degradation and Diseases**

6. Oil spillages leading to water pollution thereby killing marine animals and poisoning the land for agricultural purposes. Moreover, corrosion of petroleum equipment may lead to oil spillages as well. In industrial plants corrosion may lead to equipment failure.
7. Water erosion creates gullies and sheet giving roads and house leading to transportation problem and displacement of persons.
8. Outbreak of pest like locust, caterpillars and encroachment of wild animals such as elephants, quiller birds etc on farm settlement.
9. Outbreaks of diseases like schistosmiasis, cholera, meningitis, onchocerciasis, dracucialiansis, hepatitis etc are on the increase.
10. Fire outbreak that have gulped several millions of naira worth properties and has rendered several thousands of people homeless.
11. Respiratory tract infection is on increase. Asthma is one of such physiological problems. This problem is commonly found among workers in the cement, chalk and asbestos industries etc.
12. Radioactive materials used in medicine, nuclear weapons testing in open atmosphere and radioactive materials used in the industry and biological nuclear weapon testing. This weapon when used possess danger to African where there appear to be no protective device to counteract it.

The list can go on and on, is it is hoped that paper presented will cover some aspect of the areas listed above.

### **Marine Ecosystem and Resource Management**

Bio-economic modeling for sustainable exploitation of biological resources like in fishery and forestry are gradually finding applications in Nigeria.

It is expected that some aspect of the following problems will be addressed:

1. Flow problem, modeling of egg site and larva transportation. Trophodynamics of species to study marine life multi-species and surrogate of biomass.
2. Ocean current and circulation of nutrients as affected marine life.
3. Control of water hyacinth.
4. Engineering problems of marine type: water management, sewage system and control.
5. Energy issue and renewable energy and sustainable development issue. Simulation of engineering systems and alternative energy source different from conventional forms. Solar energy and other forms of renewable energy.
6. Water and sanitation problem.
7. Environmental impact assessment: environment epidemiology, occupational hazard, exposure assessment and remote sensing.
8. Beach problem and management.

The environment is surrounded by countless problems. It is hoped that the resources persons would address several of the problems posed above.

#### **References**

- [1] National Mathematical Centre (NMC): On establishment of Ecological Research Unit at NMC for ecological forecasting and solution to Nigerian ecological problems.Proj.Pro.No.2C, January 2003.
- [2] J.R.Thomson  
Engineering Safety Assessment. Longman Scientific and Technical Hong Kong, 1987.
- [3] Lee F.P., Loss Prevention in the Process Industries, Butterworths, 1980.