Report on COMSATS' International Thematic Research Group on Mathematical Modelling
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1. INTRODUCTION

The COMSATS' International Thematic Research Group (ITRG) on 'Mathematical Modelling' was launched by COMSATS at the National Mathematical Centre (NMC) Abuja, Nigeria on 2nd December 2014. The group is working on joint research project entitled: **Mathematical modelling and Simulation of Air and Water pollution: Effect and Remedies.**

The COMSATS' ITRG on modelling held the second meeting at Abuja on 30th December 2015 and it was unanimously agreed that the next meeting will be in Senegal in 2017

Introduction contd….

The group also gave research assignments to members which were reported in the working paper of the last 19th Meeting of COMSATS Coordinating Council meeting held CIIT, Islamabad Pakistan. The assignments involved various components of the research centrifuging on method/models for transportation and distribution of pollutants in air and water; models for studying the medical effect of heavy metals on human beings, pollution benchmark issues and estimation of the impact of pollution on the environment.

The Researchers have made headway in their studies. Consequently upon the outcome of the assignments given them some publications have been made

2. PUBLICATIONS

We report the following publications:

1. Oyelami B O

   Models for Computing Effect of Pollutants on the Lower Respiratory Tract.
   American Journal of Modelling and Optimization, 2016, Vol. 4, No. 2, 40-50.

   http://pubs.sciepub.com/ajmo/4/2/2

   DOI: 10.12691/ajmo-4-2-2.

2. Oyelami B O, Wufem B M.

   Models for Computing Emission of Carbon dioxide from Liquid fuel in Nigeria.
   American Journal of Mathematical and Computer Modeling.2017, 2(1), 29-38.

   DOI; 10.11648(j.ajmcm.20170201.15).

3. Oyelami B O. Ogidi J.A.

   Nonlinear Difference Equations and Simulation for Zooplankton-Fish model with noise.
   IOSR Journal of Mathematics (Accepted)

4. Lugano W, David L., Oyelami B O.

   Modelling CO, CO2 and NO_x evolution from small and medium size generator sets
   (Submitted for publication)

3. SUMMARY OF THE SOME OF THE FINDINGS OF THE ITRG ON MODELLING

3.1 Models for Computing Effect of Pollutants on the Lower Respiratory Tract1.

The researchers modelled the aerodynamic behaviour of particulates (pollutants) that diffuses into the airway in the human lower respiratory track (LRT) containing mixture of pollutants, water droplets and mucus.

The velocity of the airflow was computed using the Nervier Stokes equation with fractal morphologic boundaries and the population of bacteria in the mixture studied using the Lauffeger-Aris-Keller model. The series solutions to the models, the concentration of the pollutants in the LRT and the airflow velocity profile were obtained.

It was found that as the thickness of the irreversible structures formed on the walls of LRT increases then the airflow into the airway decreases. The population of bacteria was found to be stable if the if sustenance function is very small compared to the death rate of the bacteria.

The researchers concluded that, for good throughput of airflow, the muscles of the walls of breathing ducts need to be dilated with drugs or through surgery by constructing Nano pipes to allow passages of air into the air sacs by bypassing the pulmonary obstacles to enhance free flow of air into the lungs.

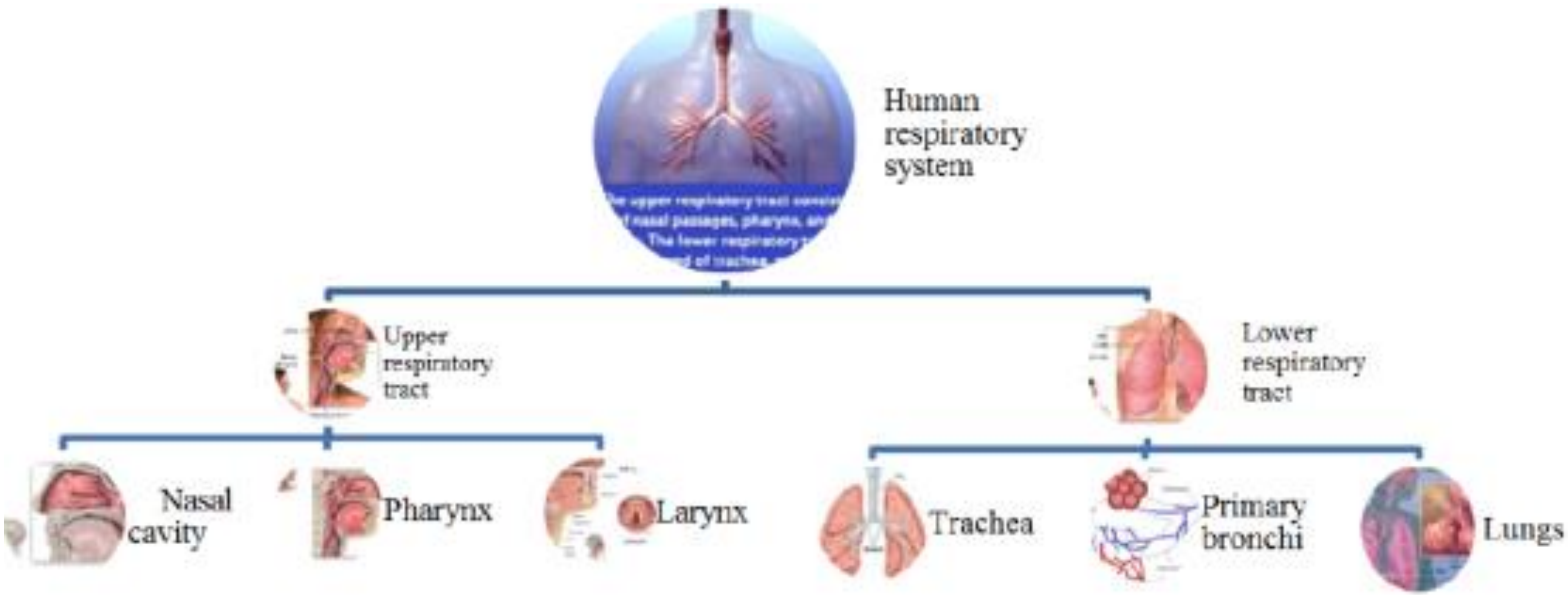
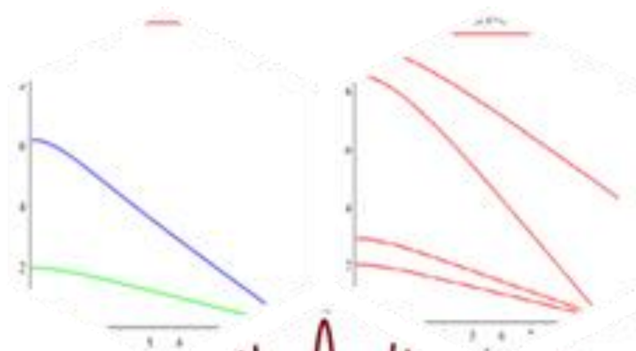


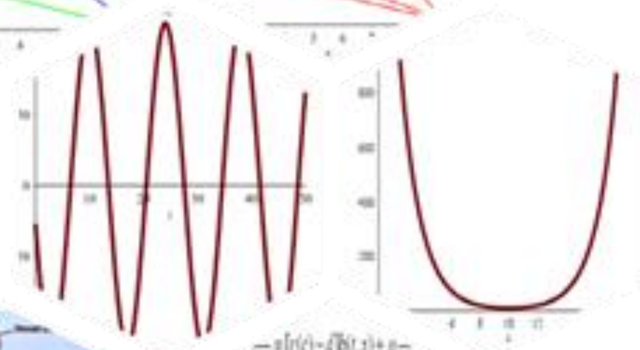
Figure 5. The Anatomy of organs responsible for human respiration

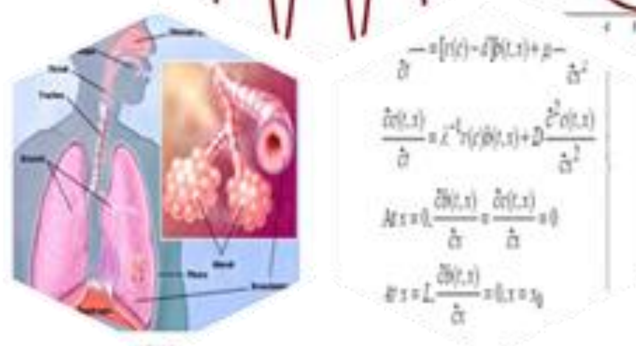
Figure 12. Animation of concentration of pollutants in the mucus using Julian fractal



flow of air into the beathing ducts deceases down the ducts

oscillatory behavour air flow in the respiratory tract





Mathematical equations for airflow

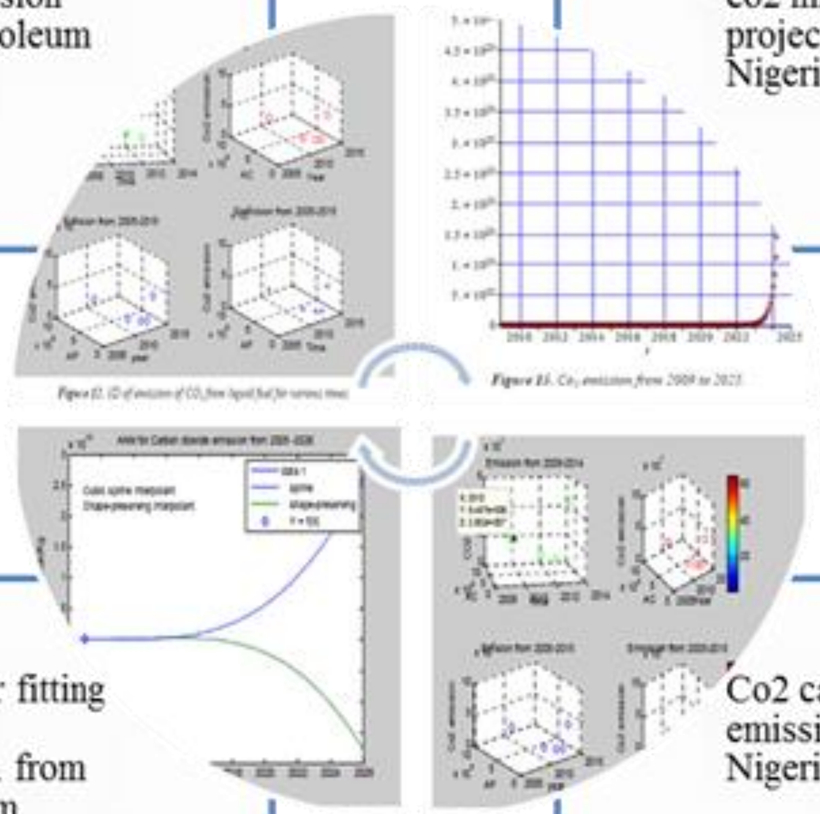
3.2. **Models for Computing Emission of Carbon Dioxide from Liquid Fuel in Nigeria**

The Researchers modelled the Carbon dioxide emission from the liquid fuel supplied in Nigeria by the Nigerian National Petroleum Corporation (NNPC) from 2009 to 2013. The CO2 emissions and CO2 emission per capita within the given period were computed and projected emission from 2013 to 2025 made using the greenhouse training equation, artificial neural network (ANN) model and polynomial interpolation method and nonlinear fitting method.

The available data from the Nigerian National Petroleum Cooperation (NNPC) was extrapolated from 2013 to 2020 using the polynomial interpolation method and the nonlinear fitting method is utilised to fit the data from 2009 to 2030.

- Co2 emission from petroleum product

- co2 mission projection for Nigeria



- Nonlinear fitting for Co2 emmision from petrolluem suppy in Nigeria

Co2 capita emission for Nigeria

3.3. Nonlinear Difference Equations and Simulation for Zooplankton-Fish Model with Noise

A nonlinear difference equation for zooplankton–fish population model with noise was considered. The model used was on predation of phytoplanktivore fishes on zooplankton. The researchers want to understand the individual organism behaviour as well as interaction with the environment.

The model used was a nonlinear logistic type of model incorporating nonlinear feeding functions. The conditions for the existence of the equilibrium points were obtained through some nonlinear equations and Diophantine equations.

The conditions for local stability for the dual population investigated and results were obtained .Simulation made for the dual populations when the ocean is polluted with chemical substances and oil spillage using Gaussian noise. The noise accounts for pollution of the ocean that may lead to species migration from the pollutants source. The scientists observed that the risk factor increases with time and makes the species to be endangered and some kind of chemo taxis effect was experienced whereby the survived species tend to migrate to region with lower concentrations of pollutants.

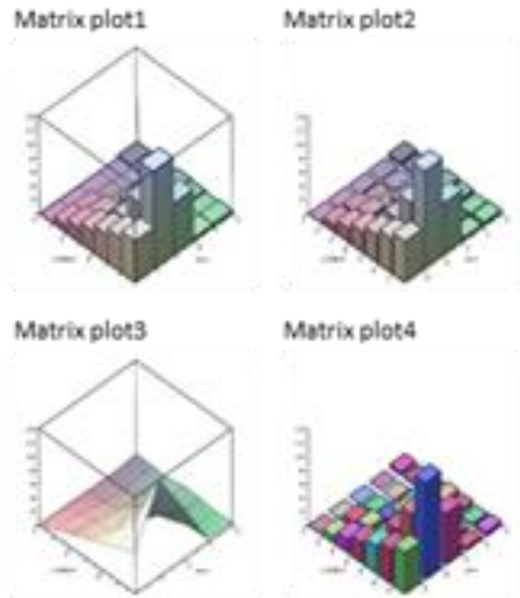


Fig. 3: Matrix plots environmental risks and frequencies of various hazard weights for the fish

The report on the Researchers working on reduction of air and water pollution through intensification, water management and biochemical oxygen demand (BOD) models will be reported to the COMSATS secretariat in due course.

4. RESEARCH TEAM/GROUP MEMBERS

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13. Dr. Wufem Buba-Plateau State University, Bokkos, Nigeria.
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