# ICAWMSCS 2025: International Conference and Advanced Workshop on Modelling and Simulation of Complex Systems

Monday, 21 July 2025 - Friday, 25 July 2025

UI Campus, Ibadan, Nigeria


# Book of Abstracts

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## Relaxed projection and contraction method with golden ratio momentum

**Author:** Hammed Abass[1]

**Co-author:** Lateef Jolaoso [2]

[1] *Sefako Makgatho Health Sciences University*

[2] *University of Southampton, UK*

**Corresponding Author:** hammedabass548@gmail.com

This paper presents a convergence analysis of a relaxed projection and contraction algorithm incorporating golden ratio constant momentum for solving monotone inclusion problems in real Hilbert spaces. The proposed method integrates a non-monotonic self-adaptive step size, a relaxation term, and a constant momentum factor derived from the golden ratio. The non-monotonic step size method allows our algorithm to adapt effectively without requiring knowledge of the Lipschitz constant, while the relaxation and momentum terms contribute to improved flexibility, acceleration and robustness. We establish both weak and linear convergence results under mild conditions. Numerical experiments are provided to illustrate the performance of the algorithm and compare it with some pertinent results in the literature.

**Plenary Talk** / **53**

## MATHEMATICAL MODELLING AND SIMULATION FOR BRIDGING SCIENCE AND FINANCE

**Author:** Olumide Adedeji[1]

[1] *LivingTrust Mortgage Bank*

**Corresponding Author:** dr.adedejiolumide@gmail.com

by Dr. Olumide Adedeji,
LivingTrust Mortgage Bank

**Contributed Talk** / **30**

## Modelling Climate Change Impacts on Phytotoxicity in Petroleum-Hydrocarbon-C Soils from Illegal Artisanal Refining Activities in Nigeria

**Author:** Iheoma Adekunle[1]

[1] *Federal University Otuoke*

**Corresponding Author:** adekunleim@fuotuoke.edu.ng

Modelling Climate Change Impacts on Phytotoxicity in Petroleum-Hydrocarbon-Contaminated Soils from Illegal Artisanal
Refining Activities in Nigeria

Nestor, B. Yeibimi, *Iheoma M. Adekunle and Isaac U Isaac*
*2Environmental Remediation Research Group, Chemistry Department,*
*Faculty of Science, Federal University Otuoke, Bayelsa State*Corresponding Authour: adekunleim@fuotuoke.edu.ng

Abstract
Illegal artisanal refining activities in the Niger Delta Region of Nigeria, with focus on Bayelsa State, have led to extensive petroleum hydrocarbon contamination of soils, posing significant ecological and food security risks. This study aims to model the potential impacts of climate change, particularly alterations in temperature versus key determinants of soil health (soil moisture, acid-base dynamics, salinity etc) on the phytotoxicity of these contaminated soils. Using a combination of relevant data analytics tools, projection models, and phytotoxicity bioassays with bio-indicator plant species. How shifting environmental variables may exacerbate or mitigate the toxicity of hydrocarbon-polluted soils was assessed. The findings underscore the complex between climate dynamics and soil contamination, highlighting the need for integrated remediation and adaptation strategies. This model provides a predictive tool for managing phytotoxic risks in vulnerable agroecosystems under changing climatic conditions to sustain and enhance food security drive.
Keywords: Climate Change, Environment, Soil Hydrocarbon Contamination, Phytotoxicity, Modelling

**Plenary Talk / 52**

## Leveraging Advanced Data Analytics for Sustainable Energy Solutions in Africa's Oil and Gas Sector

**Author:** A Adelowotan[1]

[1] *Chevron*

**Corresponding Author:** abayomi.adelowotan@chevron.com

This presentation will explore how modern data science techniques, including machine learning and predictive analytics, can be applied to optimize operations, enhance safety, and support environmental sustainability in the African energy landscape. I plan to share practical case studies and discuss the transformative potential of data-driven decision making in addressing some of the continent's energy challenges.

**Contributed talk: Room-2 (Statistics, Biostatistics and Epidemiology) / 3**

## Hybrid Analytical Approach to Solving a Typhoid Fever Model: Laplace-Adomian Decomposition with Sensitivity Analysis

**Author:** Benedict Celestine Agbata[1]

**Co-authors:** Danjuma Jibrin Yahaya [2]; Dervish Raimonda [3]

[1] *Department of Mathematics and Statistics Confluence University of Science and Technology Osara Nigeria*

[2] *Confluence University of Science and Technology Osara Nigeria*

[3] *Polytechnic University Albania*

**Corresponding Author:** agbatacelestine92@gmail.com

In this study, we develop a mathematical model to understand how typhoid fever spreads within a population. The model is built using a system of five ordinary differential equations (ODEs), and we carefully analyze it to confirm that it behaves reliably and makes sense both mathematically and in real-world epidemiological terms. To find approximate solutions, we apply the Laplace-Adomian Decomposition Method, which breaks the system into a series that converges quickly. We also perform a sensitivity analysis to explore how different parameters affect the transmission of the disease. The analysis reveals that the contact rate plays a major role which implies that reducing interactions with infected individuals or contaminated sources can significantly curb the spread of typhoid. Using MATLAB, we run simulations to visualize how the disease responds to various control measures.

The results show that timely treatment of infected people and proper handling of contaminated environments are key to effective disease control. Finally, we find that using a fractional-order version of the model offers a more accurate picture of typhoid's dynamics compared to traditional methods.
**Keywords:** Memory effects, Typhoid fever, Mathematical modeling, Ordinary Differential Equations (ODEs), Fractional-order Analysis, Sensitivity analysis

**Contributed Talk** / **7**

# IDENTIFICATION OF BRUISED FRUITS USING SMARTPHONE

**Author:** Biodun Ajayi[1]

[1] *University of ibadan*

**Corresponding Author:** ajayibiodun@gmail.com

Fruit bruising is a challenge in post-harvest handling and transportation especially in Nigeria, affecting both quality and market value. This study presents the development of an image-based bruise detection system using a smartphone camera as the imaging device. Images of tomatoes were captured and analyzed using two computational methods: Otsu's thresholding algorithm and a Random Forest Classifier (RFC). The preprocessing stage involved contrast enhancement and histogram equalization to improve feature extraction. Otsu's method calculated a global threshold value correlated with bruise severity, while RFC utilized textural features derived from Gray Level Co-occurrence Matrix (GLCM) such as entropy, contrast, correlation, energy, and homogeneity. Results demonstrated a bruise detection accuracy of 100% for the thresholding system, with RFC showing strong classification performance after training on over 3,700 labelled images. The system provides a low-cost, non-destructive, and automated method for sorting bruised fruits, offering significant potential for integration into local agricultural processing workflows.

**Contributed talk: Room-2 (Statistics, Biostatistics and Epidemiology)** / **6**

# Dynamics, Control and Stability of a Deterministic Avian Influenza Model

**Author:** AKINSUYI JAMES AKINGBADE[1]

**Co-author:** OLABODE MATHIAS BAMIGBOLA [1]

[1] *University of Ilorin*

**Corresponding Author:** akingbadejames1@gmail.com

Avian Influenza is a deadly zoonotic disease that is common in almost all parts of the world. It remain a significant public health concern due to its zoonotic nature and potential to cause wide spread outbreaks. Several mathematical models by different researchers have addressed avian influenza disease dynamics, but gaps remain in understanding the combined effects of education campaigns, vaccination, quarantine, and treatment within a compartmental framework. Thus, this study aims to bridge the gap by constructing a fourteen-compartment model divided between
human and bird populations to evaluate the effectiveness of various control measures. The human population is categorized into uneducated susceptible ($S_{uh}$), educated susceptible ($S_{eh}$), Vaccinated human ($V_h$), exposed ($E_h$), infected ($I_h$), quarantine (Q), treatment (T), and recovery classes, while the bird population includes susceptible ($S_b$), vaccinated ($V_b$), exposed ($E_b$), and infected ($I_b$) compartments. Key intervention measures such as education campaigns, initial stage vaccination, quarantine of infected humans, and treatment of affected individuals are incorporated into the model. The basic properties of the model were fully proved and discussed. The model equilibra were obtained

by solving the model system equations simultaneously. Stability analyses of the disease-free equilibrium and endemic equilibrium were conducted through techniques such as the Jacobian matrix and Lyapunov functions, confirming asymptotic stability under these conditions. The reproductive ratio, $R_o^{b,h}$, was computed using the next-generation matrix method,revealing that $R_o^{b,h} < 1$ when controls are applied at a minimum implementation level of 50\% or higher, indicating effective containment of the disease. Findings from the qualitative analysis suggested that education campaigns and related measures are highly effective in controlling avian influenza infections within the society. Quantitative analysis further supports this conclusion, with numerical simulations demonstrating a significant reduction in disease prevalence when control measures were implemented. This study underscores the importance of integrating education, vaccination, quarantine, and treatment measures in avian influenza management, offering valuable recommendations for public health policies and future research.

**Key words:** Avian Influenza; Mathematical model; Basic reproduction number; Stability; Educational campaign, Control measures.

**Contributed Talk** / **18**

## Discrete Event Simulation Investigation Into The Impact Of Distinct Service Rate Attributes Of Servers In A Multi-Server Queuing System

**Author:** Ayobami Alonge[None]

**Co-authors:** Omotunde Muyiwa ; Osita Anyaeche

**Corresponding Author:** ayobamialonge007@gmail.com

Queues are a common feature of daily life, which both service providers and customers strive to avoid. However, eliminating queues may not be possible for service providers, such as Nigerian banks, where the rate of customer arrivals exceeds most Nigerian banks'capacity to process customers'requests. Several studies have theorised that increasing the number of servers and increasing service rate of servers are valid solutions to minimize the waiting time of customers in a queue system. This study was designed to investigate the impact of distinct service rate attributes of servers in a multi-server queuing system through discrete event simulation technique.
A convenient sampling technique was used to select a Nigerian bank, and their customer-care section was selected for this study. A stratified purposive sampling was used to collect data on 427 customer transactions via direct observation using a stopwatch, with the inter-arrival and service times of customers recorded. The customer-care section consists of two distinct parallel servers. The Discrete Event Simulation (DES) technique was employed using Arena to model the queuing system to analyse service times of 210 bank customers served by Server-1 and 217 of the bank customers served by Server-2 using Arena's Input-Analyser.
It was found that by experimental modelling of replacing Server-2 with a server matching Server-1' s service rate, the waiting time increased to 78.36 minutes, while replacing Server-1 with a server matching Server-2's service rate reduced customer waiting time to 29.10 minutes from 32.42 minutes of the control scenario of a system of Server-1 and Server-2. Hence, replacing Server-1 with server that has the same attribute with Server-2 reduced bank customers'waiting time, while replacing Server-2 with server that has Server-1 attributes increased bank customers'waiting time.
The study highlights that Arena DES accurately captures varied service rate distributions, emphasizing the importance of modelling distinct server attributes for realistic queue analysis. The DES can be adopted for precise queue management and help banks assess individual server performance to minimize customer waiting time and staffing allocation. Future research should explore additional server configurations and larger datasets to enhance generalizability.
Keywords: Input-Analyser, DES, Queue, Nigerian bank, Arena

**Invited Talk** / **33**

## Parameter Estimation and Forecasting for Biased Models

**Authors:** Heikki Haario[1]; Miracle Amadi[1]

[1] *Lappeenranta-Lahti University of Technology LUT*

**Corresponding Author:** miracle.amadi@lut.fi

Traditionally, parameters of dynamical systems are estimated by directly comparing model simulations to observed data utilizing a least squares approach. However, if the models are biased, this classical approach may not accurately estimate the true states. Here, a data-driven approach is proposed that enables the model to follow the trajectory of the data. More so, following this approach, the model parameters can be adjusted in the process. The simple Ross model for malaria is used as an example, as it does not capture the impact of external factors, such as periodically changing weather patterns. A hybrid of state-augmentation and Kalman filter (KF) likelihood methods are applied to estimate both the dynamic and static parameters of the model. Data such as the monthly hospital cases from Nigeria, as well as rainfall in the same region, are utilized as a proxy in order to help the filter to produce an optimal estimate of the evolving state of the system. The idea is that the model bias translates to the parameters, in the sense that the right parameters can be estimated but with larger uncertainties. Markov Chain Monte Carlo (MCMC) is employed as a general tool to diagnose the identifiability of the static parameters. We outline some integral steps to handle model bias using KF likelihood. Examples for hospital planning are discussed: how to anticipate and prepare for potential increases in patient volume during and after periods of rainy seasons.

**Contributed talk: Room-2 (Statistics, Biostatistics and Epidemiology) / 48**

## Pairwise Network Models in Epidemiology: A Review of Approximations, Dynamics, and Applications

**Authors:** Kazeem Olalekan Aremu[1]; Muhammad Shafii Abubakar[1]

**Co-author:** Maggie Aphane [1]

[1] *Sefako Makgatho Health Sciences University*

**Corresponding Author:** aremukazeemolalekan@gmail.com

In this review, we provide a comprehensive analysis of pairwise network models in epidemiological modeling, focusing on their ability to capture local interaction dynamics and network heterogeneity. We examine key approximation techniques, including moment closures for homogeneous and heterogeneous degree networks, and discuss their role in deriving epidemic thresholds, basic reproduction numbers R_0, and final outbreak sizes. Special emphasis is placed on clustering effects, rewiring mechanisms, and the interaction between network structure among homogeneous species and disease spread. The review highlights advances in pairwise models for SIS, SIR, and SEIR dynamics, comparing analytical results with stochastic simulations on complex network topologies such as Poisson, exponential, scale-free networks, etc. Finally, we identify emerging directions, such as two-community network models in zoonotic ecology, multi-pathogen interactions, and higher-order clustered networks such as 4-node square clusters and their impact on two-community models, offering insights for future research in network science and epidemiology.

**Contributed Talk / 16**

## Numerical computation of Chemical Reaction, Heat Generation, Thermal Radiation, and Viscous Dissipation Effects on Magnetohydrodynamic (MHD) Convective Flow Through a Porous Medium

**Author:** Soluade Joseph Aroloye[1]

**Co-authors:** Israel Olutunji Abiala [2]; Olugbenga John Fenuga [1]

[1] *UNIVERSITY OF LAGOS*

[2] *UNIVERSITY OF LAGOS, NIGERIA*

**Corresponding Author:** saroloye@unilag.edu.ng

Aroloye, Soluade Joseph1, Fenuga Olugbenga John2, Abiala Israel Olutunji3
1.2.3Department of Mathematics, Faculty of Science, University of Lagos, Nigeria
Author Email: saroloye@unilag.edu.ng
This research explores the effect of viscous dissipation on free convection magnetohydrodynamic (MHD) flow through a porous medium over an exponentially stretching surface in the presence of a chemical reaction. The fundamental governing partial differential equations (PDEs) governing the problems are transformed into nonlinear ordinary differential equations (ODEs) using similarity variable. Numerical solutions are then obtained through the shooting method combined six order Runge Kutta Scheme. Maple software is used for the simulation of the problem. The characteristics of boundary layer flow, along with the behaviour near the bounding surface, and the effect of embedded flow parameters on velocity, temperature and concentration profiles are examined and interpreted through graphical illustrations. The findings indicate that an increase in the Eckert number, radiation, and magnetic parameter (M) enhances the temperature profiles, whereas a rise in the chemical reaction parameter, porosity, and Schmidt number reduces the concentration profiles. To ensure accuracy, a comparative analysis between the present results and previously published outcomes for a specific case is performed, revealing strong agreement.

**Contributed Talk** / **27**

# Numerical Simulation of a Ground-Coupled Earth-to-Air Heat Exchanger for Greenhouse Cooling in Humid Tropical Climates

**Authors:** Ayorinde Abd-Qudus Asiru[1]; M. O. Omobowale[None]; T. D. Akpenpuun[2]; Yahaya Mijinyawa[1]

[1] *University of Ibadan*

[2] *University of Ilorin*

**Corresponding Author:** ayorinde.asiru@gmail.com

The thermal performance of a ground-coupled Earth-to-Air Heat Exchanger (EAHE) system intended to cool greenhouse air in humid tropical environments is examined in this study. To simulate EAHE operation at two burial depths—1 m and 2 m—a three-dimensional computational model was created using SolidWorks and ANSYS 2023R1. In each configuration, a homogeneous, isotropic soil domain was embedded with a network of air-circulating polyvinyl chloride (PVC) pipes. A tetrahedral grid was used to mesh the geometry, yielding more than 4.7 million elements for the 2 m depth and 3.7 million for the 1 m depth. Field measurements of greenhouse air and soil temperature were used to define material properties and boundary conditions, while presumptions like steady-state operation, no-slip conditions, and constant air properties were used. The results of the simulation showed that, although performance varied by depth, the EAHE successfully cooled the inlet air as it passed through the system. The air temperature decreased from 36.7℃ to 30.6℃ at a depth of 2 meters, indicating a more consistent cooling profile throughout the pipe network. The lateral and vertical sections verified progressive cooling, and pre-cooling effects and variable airflow paths were responsible for the variations in cooling intensity across the three channels. The air temperature dropped from 32.5℃ to 30.5℃ in the first pipe sections of the 1 m depth configuration, indicating a more concentrated cooling effect. Interestingly, the horizontal pipe at the top showed the best cooling, probably because it was exposed to air that had already been cooled and because it was farther away from the heat source. The results show that burial depth has a major impact on EAHE systems' cooling effectiveness. While the 1 m depth worked well over shorter distances, especially close to the inlet, the 2 m depth offered more reliable cooling over longer distances. The ground served as an efficient heat sink in both setups, encouraging heat transfer from the moving air. This study provides insights into the best design factors, such as pipe layout and burial depth, for improved

thermal performance and validates the potential of EAHE systems for passive greenhouse cooling in humid tropical environments.

**Contributed talk: Room-2 (Statistics, Biostatistics and Epidemiology) / 13**

# BRIDGING THEORY AND EPIDEMIOLOGY: A NEXT-GENERATION MATHEMATICAL MODEL FOR MALARIA ELIMINATION STRATEGIES.

**Author:** Florence Dammy AYEGBUSI[1]

**Co-author:** AKINSUYI JAMES AKINGBADE [2]

[1] *First Technical university*

[2] *University of Ilorin*

**Corresponding Author:** florahdammy@gmail.com

BRIDGING THEORY AND EPIDEMIOLOGY: A NEXT-GENERATION MATHEMATICAL MODEL FOR MALARIA ELIMINATION STRATEGIES.

F. D. AYEGBUSI 1 And J. A. AKINGBADE 2

1 Department of Mathematics, First Technical University, KM 15, Ibadan-Lagos Expressway, Ibadan, Oyo state, Nigeria. Tel:+23470330502140,
e-mail:
florahdammy@gmail.com. , florenceayegbusi@tech-u.edu.ng. and
2 Department of Mathematics, University of Ilorin, Ilorin Kwara State Nigeria.
jaakingbade@yahoo.com, akingbadejames1@gmail.com
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ABSTRACT

Malaria remains a formidable global health challenge, necessitating advanced modeling frameworks to inform eradication strategies. Here, we present a refined mathematical model that extends classical approaches by incorporating three critical, yet often overlooked, epidemiological features: (1) waning immunity in human populations (SEIRS dynamics), (2) asymmetric transmission probabilities between vectors and hosts ($b \neq c$), and (3) disease-induced mortality. Our coupled human-mosquito system employs an SEIRS structure for humans and an SEI framework for mosquitoes, explicitly accounting for the decay of acquired immunity—a key driver of reinfection in endemic regions. The derived basic reproduction number ($R_0$) incorporates mosquito-to-human population ratios, enabling region-specific assessment of intervention efficacy.
Through equilibrium and sensitivity analyses, we demonstrate how our model outperforms conventional approaches in predicting transmission patterns, particularly in high-burden settings with persistent reinfection. Numerical simulations reveal that ignoring immunity loss (as in SEIR models) overestimates the long-term impact of mass drug administration by up to 30%, while neglecting vector-host asymmetry underestimates the required bed-net coverage for outbreak prevention. Furthermore, we identify optimal intervention thresholds by mapping $R_0$ suppression to combined strategies (e.g., vaccines + vector control).
This work provides a adaptable toolkit for policymakers, bridging theoretical epidemiology and field implementation. By aligning with recent WHO guidelines and empirical data, our framework offers a robust platform for evaluating malaria elimination campaigns in the era of insecticide resistance and climate change.

Keywords: Malaria modeling, SEIRS-SEI framework, waning immunity, basic reproduction number, asymmetric transmission, intervention optimization.

**Invited Talk / 51**

## Modeling Solar Storms in the Age of PUNCH

**Author:** Curt A. de Koning[1]

[1] *University of Colorado at Boulder*

**Corresponding Author:** dekoning@colorado.edu

By Curt. A. de Koning
University of Colorado at Boulder,
USA

**Invited Talk / 43**

## Legendre Wavelet Collocation Method for Pricing European Options governed by Jump-Diffusion Models

**Author:** Rhydal Esi Eghan[1]

**Co-authors:** Gaston Awashie [1]; Peter Amoako-Yirenkyi [1]; Akoto Yaw Omari-Sasu

[1] *Kwame Nkrumah University of Science and Technology*

**Corresponding Author:** esi.eghan@knust.edu.gh

Abstract:
Improving numerical methods used for pricing options in derivative markets becomes essential, especially where asset returns often exhibit characteristics (such as jumps, heavy tails, and asymmetry) that aren't well-suited to traditional Gaussian models. To account for these features, the research explores jump-diffusion processes governed by an integro-differential equation (IDE), where the integral term represents the jumps in asset prices. Since closed-form solutions for these equations are generally unavailable, numerical methods are used, but they often involve complex matrices and slow computations. The study proposes using the Legendre wavelet collocation method (LWCM) as a more efficient and simple alternative to approximate Merton's jump diffusion model. It specifically models jump magnitudes with a log-logistic distribution.
The key findings highlight that the LWCM is a simple yet robust method that closely approximates Merton's analytical solution. This approximation is achieved with high convergence rates in both L_2 and L_infty norms, showcasing the method's efficiency. This makes it a promising numerical tool for option traders looking to integrate jump-diffusion models into their pricing strategies.

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## Hands on Workshop- Symmetry Analysis of Differential Equations

At the end of this workshop, participants will be able to
 Understand what is meant by the invariance of a differential equation
 Understand the concept of group transformations
 Derive infinitesimal transformations of the Lie group of transformations
 Determine Lie point symmetries of ordinary differential equations
 Use the derived Lie point symmetries to integrate ordinary differential equations
 Determine Lie point symmetries of Partial differential equations
 Use the derived Lie point symmetries of partial differential equations to determine similarity solutions which are then used to reduce partial differential equations to ordinary differential equations

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## Hands-on workshop on Machine learning and Data Science

Workshop Learning Objectives
At the end of this workshop, participants will understand

 Pandas Objects
 How to Read and View Data within the pandas framework
 Data Indexing and Selection
 Operations on DataFrame

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## Hands on workshop on Machine learning and Data Science

**Author:** Solomon Gizaw[1]

[1] *University of Addis Ababa University*

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**38**

## Hands on workshop on Machine learning and Data Science

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**Contributed Talk / 32**

## Simulating Impact of Climate Variables and Soil Health Dynamics for Enhanced Production of Bell Pepper Species in Nigeria's Coastal Niger Delta Region

**Author:** Isaac Isaac[1]

**Co-author:** Iheoma Adekunle [1]

[1] *Federal University Otuoke*

**Corresponding Author:** isaacui@fuotuoke.edu.ng

The study conducted in the Niger Delta region explored the potential of simulation-based modeling to understand the interactive influence of climate variables and soil health dynamics on bell pepper (Capsicum species) growth in coastal Nigeria. By integrating agrometeorological datasets and soil diagnostic indicators, the study simulated key production scenarios under projected climatic shifts. The results showed that advanced environmental modeling platforms can examine temperature thresholds, soil organic matter variation, and moisture availability as critical drivers of phenological behavior in bell pepper cultivars. The study emphasized the importance of climate-smart agronomic strategies such as precision irrigation, organic soil amendments, and controlled-environment agriculture in stabilizing yield outcomes amidst environmental stressors. The simulated framework incorporated bio-indicator response profiling to detect early signs of abiotic stress, providing a basis for tailoring site-specific interventions. The findings promise to inform adaptive agripreneurial practices, contribute to climate-resilient food systems, and support evidence-driven policy decisions. The study demonstrated the effectiveness of simulation-based modeling in enhancing productivity and sustainability in vulnerable agroecosystems. By bridging environmental diagnostics with smart cultivation, the study provides a dynamic blueprint for improving agricultural practices. The positive outcomes can inform policy decisions and support the development of climate-resilient agricultural systems. The study's findings have significant implications for agricultural productivity and sustainability in the Niger Delta region. Adopting climate-smart agronomic strategies and using simulation-based modeling can help farmers and policymakers improve crop yields, reduce the impact of climate change, and promote sustainable agricultural practices.

**Contributed Talk / 26**

# Finite Element Simulation of Nuclear Blast Waves with Time-Varying Source Energy: Mathematical Modeling, Algorithm, and 3D Visualization

**Author:** LAWAL Isamil Olusegun[1]

**Co-authors:** Ibigbami Oluwole Nelson [1]; Mbadiwe S. Benyeogor [2]; Negedu Moses Ugbedeojo [3]; OJELADE JELILI ADEMOLA [1]

[1] *NATIONAL SPACE RESEARCH AND DEVLOPMENT AGENCY*

[2] *Michigan Technological University, Houghton, Michigan, United States*

[3] *NATIONAL SPACE RESEARCH AND DEVLOPMENT AGENCY. ADVANCED AEROSPACE ENGINES LABORATORY.*

**Corresponding Author:** deansegun@gmail.com

This research paper introduces a finite element simulation approach to investigate the characteristics of nuclear blast waves, considering time-varying sources. The simulation methodology is founded on the blast wave equation and employs numerical techniques to solve for the temporal evolutions of pressure distribution. Notably, the model incorporates a time-varying source term denoted as S, facilitating the simulation of nuclear explosions with dynamically changing intensity within a localized range around the epicenter. This capability allows for the estimation of the blast's destructive potential by examining the resultant vacuum formation. The paper offers a comprehensive exposition of the mathematical formulation underlying the simulation model, accompanied by its implementation algorithm in Python using finite element computation. Moreover, the study encompasses a numerical calculation that explores the blast energy as a function of the source term, enhancing the understanding of blast dynamics. The results are presented as 3D color-coded plots, enabling a clear visualization of the pressure distribution across a defined distance and its temporal evolution. Notably, the plot provides insights into the formation of a vacuum in the vicinity of the blast epicenter. Furthermore, the discussion section critically examines the scope and limitations of the computational process, offering valuable insights into the accuracy and applicability of the model. This thorough evaluation enhances the understanding of the model's capabilities and computational constraints. By offering a powerful simulation tool for comprehending the behavior of nuclear blast waves, this study contributes to the field of disaster response and preparedness. It equips researchers and practitioners with valuable insights that can inform effective strategies and decision-making in mitigating the impact of nuclear incidents.

**KEYWORDS: Index Terms—blast wave, finite element method, nuclear blast, pressure disturbance, simulation, time-varying sources, wave equation.**

**Contributed Talk / 29**

# Prediction of Sand Production in Vertical Oil Wells Using Selected Machine Learning Models

**Authors:** Akorede Joledo[1]; Efe Igwe[2]; Segun Balogun[3]

[1] *University of Ibandan*

[2] *Renaissance Energy Company, Africa*

[3] *University of Ibadan*

**Corresponding Author:** ao.joledo@ui.edu.ng

The occurrence of sand production during hydrocarbon extraction operations presents significant challenges, as it can lead to equipment damage, pipeline blockages, and reduced well lifespan. Accurate real-time estimation of sand volume is crucial for optimising well operational efficiency and implementing cost-effective sand control strategies. This study employed machine learning models, including Logistic Regression, Decision Tree, Random Forest, and Support Vector Machine (SVM), to

predict sand production in vertical oil wells. This study utilised actual field measurements of reservoir pressure, flow rates, rock strength data, and production parameters. The models underwent preprocessing and feature selection to achieve training results, followed by validation and evaluation using metrics such as accuracy, precision, recall, F1-score, and confusion matrices. Among the models employed, Random Forest emerged as the most accurate predictor, achieving 96% accuracy owing to its capability to identify complex nonlinear relationships between reservoir and operational features. This assessment confirmed the efficacy and reliability of machine learning as a method for active sand control and optimised well system development. The predictive frameworks developed in this study demonstrate their potential to reduce equipment failure, enhance well operational longevity, and promote sustainable production practices.

**Contributed Talk / 50**

## Thermal and Sensitivity Analysis of MHD Elastico-viscous Hybrid Nanofluid between Two Rotating Disks

**Author:** Kazeem Kasali[1]

**Co-author:** Suraju Ajadi [2]

[1] *Abiola Ajimobi Technical University*

[2] *Obafemi Awolowo University*

**Corresponding Author:** kazeemkasali2015@gmail.com

The heat and mass transfer of nanoparticle suspensions between rotating disks has gained significant research interest due to its wide industrial applications. This study investigates the thermal behaviour of magnetohydrodynamic (MHD) ethylene glycol-based elastico-viscous hybrid nanofluids, incorporating nonlinear radiation and heat source effects. The governing equations, derived from conservation laws, are transformed into a non-dimensional form and solved using the spectral local linearization method (SLLM). The method's accuracy and its convergence are established. Graphical and tabular representation of the fluid profiles demonstrates how key parameters influence fluid behaviour. Results show that increasing the thermal radiation parameter, Eckert number, heat source, and nonlinear radiation effects augment the fluid temperature. Magnetic field and elastico-viscous fluid parameters reduce tangential and axial velocities but enhance temperature distribution. Sensitivity analysis highlights the influence of each parameter near the disk walls, with the Reynolds number having the most significant effect on radial drag force. Additionally, viscous dissipation, magnetic field strength, and temperature-dependent heat sources notably affect heat transfer rates. These findings offer valuable insights for optimising systems such as processing plants, heat exchangers, and nuclear reactors.

**Contributed Talk / 47**

## A Double-Inertial Mixed Extragradient Method for Solving Bilevel Split Variational Inequality Problems and Finite Family of Fixed Points of Demicontractive Mappings

**Author:** Basirat Lawal-Akinmade[1]

**Co-authors:** Kazeem Aremu [2]; Ojen Narain [1]

[1] *University of KwaZulu-Natal, Durban, South Africa*

[2] *Department of Mathematics, Usmanu Danfodiyo University, Sokoto P.M.B. 2346, Nigeria*

This paper proposes a double-inertial mixed extragradient algorithm for solving bilevel split variational inequality problems (BSVIPs) and finding a common solution to a finite family of $k-$demicontractive

mappings. The proposed method combines Tseng's extragradient technique for the upper-level problem with the subgradient extragradient method for the lower-level problem. We establish the strong convergence of the generated sequence to the unique solution of the BSVIP without requiring the computation or estimation of the norm of the bounded linear operator. Furthermore, the algorithm incorporates a double-inertial adaptive step size to accelerate convergence and eliminates the need for restrictive assumptions such as Lipschitz continuity or co-coercivity of the involved operators.

**Invited Talk / 49**

# Mathematical Modelling of Engineering and Biological Systems: A Pathway to Technological Innovation and Sustainable Development

**Author:** Oluwole D. Makinde[1]

[1] *Faculty of Military Science, Stellenbosch University, Private Bag X2, Saldanha 7395, South Africa*

**Corresponding Author:** makinded@gmail.com

Abstract: Mathematical modelling of engineering and biological systems plays a vital role in fostering national development and driving technological innovation. By constructing precise computational representations of complex systems, researchers and engineers can predict behaviours, optimize processes, and develop cutting-edge solutions that stimulate economic progress and improve quality of life. In engineering, such models aid in designing more efficient, sustainable systems for infrastructure, transportation, and energy. In the biological sciences, they offer deeper insights into physiological mechanisms and epidemiological patterns, supporting advancements in healthcare, agriculture, and environmental sustainability. The interdisciplinary nature of mathematical modelling promotes collaboration, accelerates innovation, and strengthens a nation's leadership in science and economic competitiveness. This presentation will explore the broad applications of mathematical modelling, highlighting innovative approaches to challenges such as thermal regulation in engineering devices through nanofluid dynamics, physiological flow analysis, cardiovascular disease prevention, and the cost-effective management of ecological and epidemiological issues affecting both humans and plants.
Keywords: Mathematical Modelling; Engineering Cooling; Tissue Thermoregulation; Ecological and Epidemiological Problems.

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**Contributed talk: Room-2 (Statistics, Biostatistics and Epidemiology) / 4**

## Harnessing mathematical modeling and simulation for epidiomology and public health for African development and advancement

**Author:** Aliyu Maniru Gigane[None]

**Corresponding Author:** manirualiyugigane@gmail.com

Mathematical Modeling has emerged as a powerful tool in epidemiology and public health, enabling researchers and policy makers to predict and analyzes the disease spread , evaluate the intervention strategies and inform policy decision . In the context of African development and advancement, mathematical modeling can play a very significant role in controlling and preventing the spread of the diseases there by reducing morbidity and mortality which promote economic growth and development. The paper therefore seeks to explore the application of mathematical modeling in epidemiology and public health in Africa, highlighting its potential to inform policy decisions, optimize resource allocation and improve public health . By applying mathematical modeling , African countries can develop more effective strategies to address the lingering public heath challenges and promote sustainable development and advancement.

**Keywords:** Mathematical modeling, Epidemiology, Public Health, Advancement, Sustainable Development

**Invited Talk / 57**

## Complex Dynamics of the Concentration and Transport of Particulate Matters in the Lower Human Tract: Fractal Structures

**Author:** Promise MEBINE[1]

[1] *National Mathematical Center, Abuja*

**Corresponding Author:** p.mebine@yahoo.com

**Contributed talk: Room-2 (Statistics, Biostatistics and Epidemiology) / 12**

## CONFIRMATORY ANALYSIS OF FACTORS AFFECTING RETENTION OF FEMALE STUDENTS IN TERTIARY INSTITIONS USING BAYESIAN LOGISTIC REGRESSION MODEL

**Author:** ROTIMI OGUNDEJI[1]

[1] *Department of Statistics, Faculty of Science, University of Lagos, Lagos, Nigeria.*

**Corresponding Author:** rogundeji@unilag.edu.ng

- Rotimi Kayode Ogundeji1, Nofiu Idowu Badmus2, Anuoluwapo Oluwayemisi Aleem 3 and Motunrayo Zainab Tijani4 1,2,4Department of Statistics, Faculty of Science, University of Lagos, Akoka, Nigeria. 3Department of Statistics and Data Science, Fox School of Business, Temple University, USA. 1Email: rogundeji@unilag.edu.ng;m 2Email: nibadmus@unilag.edu.ng 3Email: tijay.motunrayo@gmail.com 2Email: anuoluwapo.aleem@temple.edu *Corresponding author: e-mail: rogundeji@unilag.edu.ng, Tel: +2348033528911

Studies have revealed that female students frequently drop out at higher rates than their male counterparts. Female students who drop out of school experience an abnormal socio-economic crisis as a result of their numerous issues. These issues may include discrimination based on gender, social pressures, and restricted access to resources. Addressing these issues is crucial in order to create a more inclusive and equitable educational environment for all students. This study demonstrates that Bayesian logistic regression is a useful and pragmatic alternative for ascertaining the factors affecting female students'retention in higher education. The study was conducted on female students of the University of Lagos. Stratified random sampling was used to obtain a target sample. The primary data were collected using questionnaires and grouped into social demographic variables, academic performance variables and academic related experience variables, based on literatures reviewed. Based on preliminary analysis and the application of Bayesian logistic regression model, the impact of identified significant predictors on female students'retention were analysed. The results identified factors that are statistically significant to students'retention and that the factors that mainly affect female students'retention were more of academic related experience variables. The Bayesian logistic regression provided a way to directly estimate the retention factors, quantify variance components and model parameter uncertainties. The study recommends provision of a support system and assigning female students to their choice of field by interest may help female students' retention.

Keywords: Bayesian Inference, Bayesian Logistic Regression, Stratified Sampling, Students Retention, UNILAG

**Contributed talk: Room-2 (Statistics, Biostatistics and Epidemiology) / 56**

# The Interplay of Gender on the Prevalence and Correlates of Depression Among Young People Living with HIV (YPLHIV) in Nigeria.

**Author:** Olayinka Omigbodun[1]

**Co-authors:** Iyeyinka Kusi-Mensah [1]; Oluwatosin Ogundipe [1]; Rita Tamambang [1]; Simeon Olaoye [1]

[1] *WEALTH Project (Women Derive Mathematical Models for Mental Health)*

**Corresponding Author:** tosinogns815@gmail.com

Abstract

Background: Nigeria has the second highest number of people living with HIV with a national prevalence of 3.2% among young people aged 15 to 24 years. In Young People Living with HIV (YPLHIV), depression is the most prevalent mental health condition which adversely impacts disease progression if left untreated. Studies suggest that rates of depression and other psychosocial factors in young people vary by gender. There is a gap in evidence concerning the interplay of gender on both the prevalence of depression and associated psychosocial factors among YPLHIV in Nigeria. The aim of this study is to explore the gender similarities and differences in the prevalence and correlates of depression among YLHIV in Nigeria.

Method: The study utilised data collected as part of the baseline assessment of the pilot study of the Intensive Collaboration Approach to Roll back the Epidemic in Nigerian Adolescents (iCARE)-Treatment study in Nigeria. This was a randomized stepped wedge trail of combination intervention of peer navigation and text message reminder delivered to youth over a period of 48 weeks to promote viral suppression in six treatment sites in Nigeria. Patients aged 15-24years who were on antiretroviral therapy for at least 3 months were recruited from the clinics and received the intervention for a period of 1 year between 2019-2020. The analysis included a sample of 541 youths (aged 15 –24 years) that was retrieved from the data. The outcome variable (Depression) was assessed using the Patient Health Questionnaire Version 9 (PHQ-9). The exploratory variables included HIV Status Disclosure, diagnosis of AIDS, Lifetime Substance Use, Social Support, HIV-Related Stigma, Medication Adherence Barriers, Medication Self-Efficacy, and Outcome Expectancy. Multivariate logistic regression was employed to identify predictors of depression in both the male and female gender. Level of significance was set at 0.05.

Result: The mean age of the participants was age 18.47 ± 2.43 years and 54% were females. The prevalence of depression 29.2%. While 20.5% had mild depression, 6.3% had moderate depression,

1.3% had moderately severe depression, and 1.1% had severe depression. The prevalence of depression in females was higher (33.6%) than in males (24.1%), (X2=5.82 p= 0.02). For males, the predictors found to be independently associated with depression included facing barriers to adherence (aOR = 1.145, p = 0.010), and experience of HIV related stigma (aOR = 2.225, p =0.012). In comparison for females, the predictors independently associated with depression were disclosing HIV status (aOR = 3.143, p < 0.001) and facing adherence barriers (aOR = 1.139, p = 0.004) whereas older age (20–24) was protective (aOR = 0.484, p = 0.025).
Conclusion: The prevalence of depression among YPLHIV is high with 3 out of 10 young people having depressive symptoms. Females are more affected than males. For the young females having disclosed HIV status and facing adherence barriers were predictors of depression while for the males'facing barriers to adherence and experience of HIV related stigma were predictors of depression. These findings highlight the necessity for focused mental health interventions aimed at reducing adherence barriers and the effects of stigma, as well as interventions to manage the impact of disclosure for young living with HIV in Nigeria.
Key words: Depression, Gender differences, Young people living with HIV

**Contributed Talk / 1**

## Hybrid FEM-RBFNN: A Fusion of Finite Element Method and Radial Basis Function Neural Networks for Solving PDEs

**Authors:** Ridwan Ojo[None]; Ajimot Adebisi[1]; K. O Kareem[None]; Muideen Ogunniran[2]

[1] *HoD Mathematical Sciences Dept, Osun State University*

[2] *Supervisor*

**Corresponding Author:** ojoridwan001@gmail.com

**Abstract**
Traditional numerical methods like the Finite Element Method (FEM) have long been relied upon for solving partial differential equations (PDEs) due to their stability and theoretical foundation. However, these methods face significant challenges when applied to problems involving complex geometries, moving boundaries, or high-dimensional spaces, where mesh generation and refinement become computationally demanding. To address these limitations, this research proposes a hybrid FEM-Radial Basis Function Neural Network (FEM-RBFNN) framework, integrating machine learning with classical numerical techniques. By embedding RBFNNs within the FEM structure, the hybrid approach enhances solution accuracy, efficiently captures sharp gradients, and improves adaptability to complex problem domains. Comparative analyses with traditional FEM demonstrate that the FEM-RBFNN method not only improves computational efficiency but also achieves superior accuracy, particularly in scenarios with challenging boundary conditions or incomplete observational data. The research highlights the capability of integrating FEM with neural networks to create more adaptable and efficient PDE solvers, hence advancing scientific computing and engineering simulations.

**Keywords**: Hybrid FEM-RBFNN, Convergence, FEM, Root Mean Square Error, Radial Basis Function, Neural Networks.

**Contributed talk: Room-2 (Statistics, Biostatistics and Epidemiology) / 14**

## An Ensemble Machine-Learning based Approach to predict Cervical High-risk Human Papillomavirus among women in Ibadan, Nigeria

**Author:** Deborah Oke[1]

**Co-authors:** Deborah Watson-Jones [2]; Imran Morhason-Bello [3]; Isaac Adewole [4]; Joshua Akinyemi [5]; Lifang Hou [6]; Yinan Zheng [6]

[1] *Department of Epidemiology & Medical Statistics, Faculty of Public Health, University of Ibadan, Ibadan, Nigeria. HPV Consortium, College of Medicine, University of Ibadan, Ibadan, Nigeria.*

[2] *1. Department of Clinical Research, Faculty of Infectious and Tropical Diseases, London School of Hygiene and Tropical Medicine, London, UK. 2. Mwanza Intervention Trials Unit, National Institute of Medical Research Mwanza, Tanzania*

[3] *1. HPV Consortium, College of Medicine, University of Ibadan, Ibadan, Nigeria. 2. Department of Obstetrics & Gynaecology, Faculty of Clinical Sciences, University of Ibadan, Nigeria. 3. Institute for Advanced Medical Research and Training, College of Medicine, University of Ibadan, Ibadan, Nigeria*

[4] *Department of Obstetrics & Gynaecology, Faculty of Clinical Sciences, University of Ibadan*

[5] *1. Department of Epidemiology & Medical Statistics, Faculty of Public Health, University of Ibadan, Ibadan, Nigeria. 2. Institute for Advanced Medical Research and Training, College of Medicine, University of Ibadan, Ibadan, Nigeria. 3.Infectious Disease Institute, College of Medicine, University of Ibadan, Ibadan, Nigeria.*

[6] *Department of Preventive Medicine, Feinberg School of Medicine, Northwestern University, Chicago, USA*

**Corresponding Author:** olamiposiowoeye@gmail.com

Persistence of cervical high-risk human papillomavirus (hrHPV) is a necessary cause of cervical cancer (CC) that remains a significant public health concern globally. Although CC is largely preventable, it is still cause of mortality in adult women especially in sub-Saharan Africa. Screening for CC precancer and early invasive cancer is pivotal to a successful elimination strategy in any country. This study provides insight on how to efficiently profile women with cervical hrHPV by using an Ensemble Machine Learning (EML) classifier.

This analysis used data from Sexual Behaviours and HPV Infections among Nigerians in Ibadan (SHINI) study to develop models for cervical hrHPV. Relevant data were extracted to develop an ensemble model. The ensemble model was based on Logistic Regression (LR), Decision Tree (DT), Naïve Bayes (NB), K-Nearest Neighbor (KNN), Support Vector Machine (SVM), and Artificial Neural Network (ANN). The data was divided into training (70) and testing sets (30). Model performance was assessed using Area Under the Receiver Operating Curve (AUC-ROC), accuracy, and F1-score. A value greater than or equal to 0.7 was adjudged as a good model.

The features extracted included age, ethnicity, income, multiple sexual partners, condom use, alcohol use, cigarette smoking, illicit drug use, knowledge of HPV, ever had anal sex, and prior anal HPV infection. The AUC for training (testing) data was 0.74(0.83)for EML; 0.77(0.79) for LR, 0.99(0.63)for DT, 0.73(0.78) for NB, 0.89(0.73) for KNN, 0.77(0.78) for SVM, and 0.73(0.74) for ANN. Accuracy for training (testing) data was 0.73(0.76) for EML, 0.72(0.71) for LR, 0.98(0.63) for DT, 0.66(0.67) for NB, 0.83(0.70) for KNN, 0.73(0.69) for SVM, and 0.73(0.73) for ANN. F1-score were 0.78(0.79) for EML, 0.79(0.76) for LR, 0.99(0.66) for DT, 0.71(0.68) for NB, 0.85(0.72) for KNN, 0.78(0.73) for SVM, and 0.79(0.76) for ANN in training (testing) respectively.

The EML model demonstrated superior predictive performance for cervical hrHPV, highlighting its potential to enhance risk stratification and inform targeted screening and intervention strategies in Nigeria and other resource-limited settings.

**Contributed talk: Room-2 (Statistics, Biostatistics and Epidemiology) / 9**

## A Comparative Analysis of Traditional and Structured Allometry Growth Models with Machine Learning Intergration

**Author:** Samuel Oke[None]

**Co-author:** Samuel Oyamakin

**Corresponding Author:** samuelabayomi13@gmail.com

This study presents a comparative analysis of traditional growth models with proposed models based on a structured allometry parameter theta, conditioned on the intrinsic rate of increase. Solutions to these proposed models were derived by solving their respective ordinary differential equations to model population size and predict demographic processes in Nigeria, with machine learning approaches employed to enhance predictive accuracy. By evaluating existing models against newly

proposed frameworks, this research identifies the most effective approaches for capturing Nigeria's complex demographic dynamics. The exponential growth equation was modified through the introduction of a structured allometry parameter. Through a combination of visual representations and statistical metrics, a detailed picture of population trends and modeling effectiveness was established. The findings demonstrate varying applicability of mathematical growth models to Nigeria's demographic reality, with the proposed model 3 emerging as the most effective framework despite acknowledging persistent limitations common to all models. The application of machine learning approaches through systematic data partitioning and validation enhances methodological rigor in demographic modeling, moving beyond simple curve fitting to assess genuine predictive capability. Results suggest that future advances in demographic modeling will require interdisciplinary approaches integrating mathematical modeling with deeper understanding of socioeconomic factors, policy impacts, and migration patterns.

**Contributed Talk** / **17**

## Advancing Marine Ecosystem Conservation: Object Detection with AUVs and Real-time Algorithms

**Author:** Timileyin Okoya[1]

**Co-authors:** Folasade Dahunsi [2]; Olufunso Alowolodu [2]; Waliu Apena [2]

[1] *Lead City University*

[2] *Federal University of Technology Akure*

**Corresponding Author:** okoya.timileyin@lcu.edu.ng

Advancements in computer vision, particularly in image segmentation and object detection, play a pivotal role in marine ecosystem monitoring—an essential component of conservation efforts. However, traditional underwater object detection systems often suffer from limitations such as poor visibility, low-quality imagery, high computational costs, and inadequate performance in real-time scenarios, especially when faced with diverse marine species and complex underwater environments. Additionally, the inherent risks and impracticality of manual human observation in these environments underscore the need for efficient automation. To address these challenges, the development and deployment of Autonomous Underwater Vehicles (AUVs) for fish monitoring in aquaculture and fisheries management have become imperative. This research focuses on improving real-time underwater object detection using advanced algorithms, specifically masked convolutional neural networks implemented via Detectron2, a state-of-the-art library developed by Meta AI Research. Utilizing the Google Open Fish dataset—which contains a wide variety of fish species differing in size, shape, and appearance—the study assesses performance using metrics such as precision, recall, Intersection over Union (IoU), and mean Average Precision (mAP). Through multiple training iterations and fine-tuning, the approach demonstrates significant improvements in detection accuracy, thereby validating its effectiveness for practical deployment in marine conservation and aquaculture applications.
Keywords: Marine Ecosystem Conservation, Autonomous Underwater Vehicles (AUVs), Realtime Object Detection, Detectron2, Fish Monitoring and Identification

**Contributed Talk** / **44**

## Development of Plastic Waste Reverse Logistics Facility Location Model

**Author:** Oladunni Okunade[1]

**Co-author:** Bright Udoette [2]

[1] *Univesity of Ibadan*

[2] *University of Ibadan*

**Corresponding Author:** dunniokunade@gmail.com

Plastic waste pollution poses a major threat to the global environment. Interventions from the government and international authorities have helped mitigate the effects of plastic waste. Despite interventions from governments and international bodies like bans on single-use plastics, plastic waste pollution remains a pressing environmental issue. This necessitated the development of a reverse logistics system that is effective in the collection of plastic waste for recycling.
The study applied the p-median model to determine the optimal location for a fixed number of plastic waste collection centres in the wards in Ibadan North West local government area, Ibadan, with the objectives of optimising the cost associated with the setting up of the collection centre, transportation and incentives distribution. A Geographical Information System was used to determine the distance of the centroid point of each ward to the recycling station.
The model selected the following wards: Inalende, Oritamerin, Abebi, and Bere as the optimal locations to site the collection centres. The study demonstrates strategic location of plastic waste collection points has the potential to significantly enhance plastic waste recovery efforts, promote responsible waste disposal practices, and contribute to a cleaner environment.
This approach offers a replicable framework for other municipalities struggling with plastic waste pollution, paving the way for a more sustainable future.

**Contributed talk: Room-2 (Statistics, Biostatistics and Epidemiology) / 5**

# ON THE ADVANCED PREDICTIVE MODELLING FOR CERVICAL CANCER DIAGNOSIS USING SUPPORT VECTOR MACHINE

**Author:** Oladapo Oladoja[1]

**Co-author:** Abosede Adepoju [2]

[1] *Abiola Ajimobi Technical University, Ibadan*

[2] *University of Ibadan, Ibadan, Nigeria*

**Corresponding Author:** oladapo.oladoja@tech-u.edu.ng

Cervical cancer is a leading cause of death among women particularly in developing countries, and often arises from abnormal cell growth in the cervix. Various risk factors contribute to its development, and statistical models can help predict its occurrence. It remains an important and public health concern, especially in regions where fundamental screening programs and diagnosis efficiency face ongoing challenges. The current diagnostic practices rely on invasive methods and subjective evaluations resulting in late-stage detection and increased mortality rates. Studies have not yet integrated Statistics methods with Support Vector Machines (SVM) and interpretable Artificial Intelligence (AI) approaches to boost reliable and understandable cervical cancer risk prediction. This study therefore aimed to fill this gap by using Principal Component Analysis (PCA) and Mutual Information (MI) for feature selection and compare the predictive performance of Logistics Regression (LR) model and SVM.
The traditional multiple linear regression is the framework for this study. Predicting qualitative responses, a process known as classification, can be a daunting challenge. To enhance model interpretability and reduce feature dimensions, feature selection was performed using the combination of MI and PCA. Two predictive models were developed using LR as the baseline classifier and SVM for nonlinear classification. The models were evaluated by using accuracy, sensitivity, specificity, Positive Predicted Value (PPV), Negative Predicted Value (NPV), Balanced Accuracy (BA), kappa statistics and area under the curve (AUC). Datasets containing diagnostic indicators of cervical cancer from UCI Repository was used. It comprised demographic information, habits, and historic medical records of 858 patients with 36 features.
Mutual Information was used to determine the most relevant predictors for the presence of cervical cancer (Biopsy). Principal Component Analysis results indicate that the first two principal components, x-axis (Dim 1: 11.55%) and y-axis (Dim 2: 8.39%), together explain 19.94% of the total variance in the dataset. The LR model shows Schiller (8.80e-08), Citology (0.035774) and Dx (0.000388) are significant in predicting the presence of cancer at 0.05 significance level. The performance metrics for LR and SVM were; accuracy (55.56%; 94.78%), sensitivity (100%; 94.86%), specificity (0%, 93.75%),

PPV (55.56%; 99.51%), NPV (NaN; 57.69%), BA (50%, 94.30%), Kappa (0.00; 0.6874) and AUC (0.9221; 0.9804). These results indicate that SVM significantly outperforms LR in cervical cancer prediction, demonstrating higher accuracy, balanced ability to identify both cancerous and healthy cases, higher precision, with fewer false positives, stronger agreement, and a superior AUC.
For cervical cancer detection, Support Vector Machine is preferred to Logistic Regression as it provides a better balance between sensitivity and specificity, has a much lower false positive rate, and correctly classifies most cases. Healthcare professionals can confidently rely on model predictions due to their interpretable features, which facilitate informed medical decision-making.
Keywords: Logistic Regression, Principal Component Analysis, Balanced Accuracy, Prediction Models

**Contributed Talk / 46**

## Hierarchical Electricity Demand Forecast Reconciliation with Time Series Filters

**Author:** Oyebola Olasupo[1]

**Co-authors:** T.R Ayodele [1]; A.S.O Ogunjuyigbe [1]

[1] *University of Ibadan*

**Corresponding Author:** oolasupo8962@stu.ui.edu.ng

Accurate electricity demand forecasting is essential for power system planning, but misaligned forecasts in deregulated markets cause inefficiencies like increased costs and grid instability. This study proposes a framework integrating seasonal-trend decomposition (STL) with Hodrick-Prescott (HP) and Christiano-Fitzgerald (CF) filters to enhance hierarchical forecast accuracy. Using monthly peak load data from the Nigerian power system, it evaluates optimal reconciliation methods. The CF symmetric filter method improved forecast accuracy as compared to direct methods and also outperformed the HP filter approach. The results also highlight the importance of selecting appropriate reconciliation methods based on the base forecasting method. These findings advance hierarchical forecasting, enhancing grid reliability and supports the reduction of planning costs.

**Contributed talk: Room-2 (Statistics, Biostatistics and Epidemiology) / 55**

## Comparative analysis of maize cob-derived biochar on selected vegetables raised on dumpsite soil

**Author:** Hannah Olukoyejo[1]

**Co-authors:** Aderonke Okoya [2]; Gabriel Olawepo [3]

[1] *Solid Waste, Water and Environmental Chemistry( SwWECh) Research unit and Laboratory, Institute of Ecology and Environmental Studies. Obafemi Awolowo University, Ile - Ife Nigeria.*

[2] *Institute of Ecology and Environmental Management, Obafemi Awolowo University, Nigeria*

[3] *University of ilorin*

**Corresponding Author:** olukoyejooluwakemi@gmail.com

Indiscriminate dumping of waste is one of the major sources of pollution to the environment. Clean up of these wastes has led to appearance of dumpsites which has been used as farmlands. This study was carried out to assess the mobility potential of the Heavy Metals (HM) in selected vegetables with biochar application as composite component of dumpsite soil using Atomic Absorption Spectrophotometer (AAS). Biochar was prepared by slow pyrolysis of Maize cobs. Maize cob biochar (MB) increased the growth yields of S. lycopersicon from 47% - 53% and Abelmoschus esculentum

from 36.4%- 63.6%. There was significant reduction ($p \leq 0.05$) in the HMs concentration from (2.78-2.36, 25.0-16.8, 11.5-7.28, 1002-418.7, 24.22-19.29,178.8-178.30mg/kg) for Cd, Pb, Ni, Fe, Cu and Zn respectively. There was % reduction in all the heavy metals concentration from 33.1%- 17.1%, 29.5% - 26.5% and 31.7%- 24.4mg/kg of the soil amended with the MB where Abelmoschus esculentum and S. lycoperscon were planted. Abelmoschus esculentum accumulated Ni, Cu, and Zn but not Cd, Pb and Fe, while S. lycopersicon did not accumulate all the investigated HMs. This study shows that indiscriminate dumping of waste contributed to HMs contamination of dumpsite soil and crops raised on them. It is recommended that maize cob biochar can be used as an effective method to reduce the HMs load in soil and crops grown on them to avert the health hazards that may result in humans and animals that consume the vegetables and weeds.

Key words -Heavy metals, biomass, Maize cob, Biochar, mobility potential

**Contributed Talk / 40**

## Two-Phase Gas Compressibility Factor Correlation for Gas Condensate Reservoirs

**Author:** Benjamin Orisamika[1]

**Co-authors:** Taiwo Oluwole-young [1]; Sunday Isehunwa [1]

[1] *University of Ibadan*

**Corresponding Authors:** taiwooluwoleyoung@gmail.com, orisbenseyi@yahoo.com

Accurate determination of the two-phase gas compressibility factor (Z_2ph ) is crucial for reliable material balance calculations, reserve estimation, and production forecasting in rich gas condensate reservoirs. Although, experimental measurement of Z_2ph is the most accurate method, but it is expensive and time consuming. Also, existing correlations and genetic algorithm-based models often produce significant errors especially for systems containing rich condensates and non-hydrocarbon impurities. In this study, a new correlation was developed to estimate Z_2ph using datasets obtained from constant-volume retrograde gas depletion studies with C_(7+) concentration ≥2mol%.
A correlation developed based on Multiple Linear Regression (MLR) was used to calculate the pseudo-critical pressure (P_pc ) and pseudo-critical temperature (T_pc ) from the gas composition. These pseudo-critical properties were used to calculate the pseudo-reduced pressure (P_pr ) and pseudo-reduced temperature (T_pr ). Two correlations for Z_2ph were developed using linear MLR and non-linear MLR. The non-linear MLR also contains the interaction terms (P_pr,T_pr ) and the quadratic terms (P_pr^2,T_pr^2 ) to capture complex gas behavior.
The non-linear MLR, linear MLR, Rayes et al. (1992), and GA correlations had average error and maximum deviation of 0.06% and 0.09%, 0.38% and 0.83%, 2.92% and 5.08%, and 2.51% and 3.86%, respectively. Therefore, the non-linear MLR is more accurate in determining the Z_2ph for gas condensate reservoirs compared to the GA and Rayes et al. (1992) correlations.

Keywords: Two-phase Gas Compressibility Factor, Gas Condensate Reservoirs, Correlation, Multiple Linear Regression, Pseudo-critical Properties

**Contributed Talk / 10**

## APPLICATION OF 3D MODELLING TECHNIQUES FOR THE ERGONOMIC IMPROVEMENT OF A MANUFACTURING ASSEMBLY LINE WORKSTATION

**Author:** Omotunde Muyiwa[1]

**Co-authors:** Emmanuel Olaleye [1]; Kolawole Oriolowo [1]

[1] *University of Ibadan*

**Corresponding Authors:** kolaorry@gmail.com, folatunde2004@gmail.com

Ergonomic workstation design is critical for improving productivity and occupational health in manufacturing environments. Studies have shown that Assembly Line Workstations (ALW) expose workers to repetitive tasks, prolonged physical exertion, and constrained postures, which increase the risk of musculoskeletal disorders, fatigue, and absenteeism. This study applied 3D modelling and digital human simulation techniques to assess, analyse, and redesign an ALW for ergonomic improvement and worker wellness. A purposive sampling technique was used to select fifty experienced assembly line workers from a manufacturing facility in Nigeria. Data on ergonomic discomfort, task-related fatigue, tool accessibility, and workstation limitations were collected using structured questionnaires and direct observation. The Rapid Upper Limb Assessment (RULA) method was employed to determine ergonomic risk levels, with scores categorised as low (1-2), medium (3-4), high (5-6), and very high (above 7). Fusion 360 software was used for 2D and 3D sketching and modelling the existing ALW. Digital human modelling software (Jack Siemens 8.4) was used to create a virtual redesign using standard anthropometric data from the literature, allowing posture analysis and ergonomic risk assessments in the virtual environment. Findings showed 44% of participants were aged 18-25 years, while 56% were aged 26-35. Participants reported spending 8-12 hours at the workstation. Reported discomfort levels were always (12%), often (8%), sometimes (62%), rarely (10%), and never (8%). Perceived posture comfort levels were: comfortable (4%), slightly comfortable (20%), uncomfortable (40%), and very uncomfortable (36%). Frequent bending was reported by 76% of participants, and 76% also indicated insufficient workspace. Pain was reported in the neck (4%), shoulder (6%), arm (8%), back (40%), wrists (18%), hand (10%), legs (6%), and feet (8%). Tool accessibility was poor, with 86% stating tools were out of reach, leading to postural strain. 90% of workers experienced prolonged discomfort due to poor postures at the existing ALW. The redesigned workstation allowed workers to maintain neutral postures, resulting in a RULA score of 2.0, which indicates low ergonomic risk. Improvements included adjustments to seat height (to match knee-hip ratios), tool reach distances (to optimize access), and working angles (to reduce fatigue and improve posture). This study demonstrates the practical benefits of integrating 3D modelling and digital human simulation in ergonomic workstation design. It highlights the potential to reduce postural hazards, enhance worker comfort, and improve productivity. Organizations are encouraged to adopt digital human modelling tools to create a safe, healthy, and efficient manufacturing environment.

Keywords: Digital human modelling, Workstation design, 3D Modelling, Musculoskeletal disorder, Assembly line workstation

**Contributed talk: Room-2 (Statistics, Biostatistics and Epidemiology) / 25**

## Predictive Mass and Volume Models for African Star Apple Based on the Geometrical Attributes

**Author:** Babatunde Oyefeso[1]

**Co-authors:** Ifemsochukwu Akwunwa [1]; Peace Ajayi [1]

[1] *University of Ibadan*

**Corresponding Authors:** oyefesobabatunde@gmail.com, erihh92@gmail.com

Physical properties of crops provide a vivid description of their sizes, shapes and behavioural characteristics which can be the basis for classification during handling and processing. Accurate prediction of mass and volume, among other important physical characteristics of crops, is crucial in the design of postharvest handling systems, particularly for sorting, grading and packaging of fruits and vegetables. This study therefore, focused on determining some physical attributes of African star apple and developing mathematical models to estimate the mass and volume of the fruits based on selected geometrical attributes. A total of 150 fresh African star apples were purchased from Oje Market in Ibadan, Oyo State, Nigeria, and classified into two groups for model development:

prediction models (100 samples) and validation models (50 samples). The procedure involved gravimetric properties measurement which included the mass and volume measurement, geometrical attributes measurement of the axial dimensions (length, width, thickness) along the three mutually-perpendicular axes, from which their mean diameters [arithmetic mean diameter (AMD), geometric mean diameter (GMD), and equivalent mean diameter (EMD)] and projected areas were calculated. Regression analysis was carried out to develop the predictive mathematical models based on three classifications: axial dimensions, projected areas, and mass models based on volume. The accuracy of evaluation of the models developed was determined by the coefficient of determination (R2). The length, width, thickness of African star apple fruits were 45.01±2.28, 43.88±2.52, and 44.22±2.30 mm, while the projected areas ranged from 1094.33 to 1951.187 $mm^2$. The gravimetric analysis showed average mass and volume of 57.36±7.46 g, and 54.75±7.34 $cm^3$, respectively. Among the developed models, those based on individual axial dimensions showed moderate correlation coefficients ($R^2$ = 0.514-0.632), with length-based models being the best among single-variable models. The longitudinal projected area models demonstrated a more predictive capability amongst all projected area models ($R^2$ = 0.607). The most accurate prediction was achieved by the mass model based on volume ($R^2$ = 0.9902), establishing a more highly reliable relationship between these parameters for African star apple fruits. The study established that mass can be accurately predicted using volume measurements, confirming findings from similar studies on other agricultural products. The developed models provide essential data for designing postharvest handling and processing systems for African star apples, contributing to the mechanization of unit operations currently performed manually. These predictive mathematical models will facilitate the development of automated sorting and grading equipment, ultimately reducing processing costs and improving efficiency in African star apple value chain operations.
Keywords: African star apple, physical properties; mass/volume modelling, geometrical attribute; size and shape indicators

**Contributed Talk / 34**

# A NATURAL LANGUAGE PROCESSING ANALYSIS OF SOCIAL MEDIA DISCOURSE ON PERCEPTION AND BARRIERS TO COMPRESSED NATURAL GAS ADOPTION IN NIGERIA

**Author:** Peace Peter[1]

[1] *CPEEL*

**Corresponding Author:** peaceabigailpeter@gmail.com

The adoption of Compressed Natural Gas (CNG) as an alternative fuel for vehicles has been promoted in Nigeria through the Presidential CNG Initiative (PCNGi) as a cost-effective and environmentally friendly solution to rising fuel costs and carbon emissions. However, public skepticism and infrastructural limitations pose significant barriers to widespread adoption. This study investigates public sentiment, concerns, and barriers to CNG adoption in Nigeria.

Using two Natural Language Processing (NLP) techniques, Aspect-Based Sentiment Analysis and Topic Modelling, qualitative data from X and Facebook were analyzed to uncover sentiment trends, prevailing concerns, and policy recommendations. The results indicate a dominant skepticism toward CNG, with high levels of invalid perceptions about CNG and NGVs, major barriers revolving around infrastructure limitations, high conversion costs, and distrust in government-led energy policies. Despite these challenges, some respondents acknowledge the cost-saving benefits of CNG, emphasizing the need for better infrastructure, awareness campaigns, and government incentives.

The study highlights the crucial role of public perception in shaping energy transition policies. Findings suggest that addressing safety concerns, ensuring equitable access to infrastructure, and fostering trust in the initiative are essential for driving adoption. These insights provide a foundation for policymakers and industry stakeholders to refine their strategies and enhance the successful implementation of CNG adoption in Nigeria.

## Hands on Workshop- Biostatistics and Epidemiology

At the end of this workshop, participants will be able to
• explain basic statistical concepts and terminologies used in statistics and health sciences
• define research hypotheses, determine the appropriate research design, and evaluate evidence in support or against hypotheses
• evaluate the basic assumptions underlying common biostatistical tests used in health sciences research
• Identify which type of regression models should be utilized depending on the nature of the data at hand and the actual research questions to be answered
• determine the appropriate model-building strategies that should be used
• correctly interpret analysis results obtained from statistical software packages

**23**

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**Contributed Talk / 2**

## Parametric sensitivities of gravity and electroosmotic-driven ternary composite nanoparticles past a Riga device with heat gain and convective cooling

**Author:** Sulyman Olakunle Salawu[1]

[1] *Bowen University*

**Corresponding Author:** kunlesalawu2@gmail.com

The study of ternary composite nanofluids has been given noteworthy attention because of their flow enhancement and thermal properties, making them a useful thermal transport application. The modulation of electroosmotic flow and integration of gravity with a Riga device in fluid transport control and energy dissipation are essential for optimizing the performance of cooling systems, microfluidics, and energy applications. Thus, this research focuses on the parametric sensitivities of gravity and electroosmotic-driven tri-composite nanoparticles of aluminum oxide (Al2O3), graphite, and carbon nanotube (CNT) propagated in a water-based fluid flowing past a Riga plate. The combined effects of gravity variation, electroosmotic force, and magnetohydrodynamic (MHD) control via the Riga plate are studied for flow stability optimization and effective heat transfer. A hybrid numerical-analytical technique solves the invariant nonlinear dimensionless equations. Sensitivity analyses revealed that gravity variation momentously influences thermal boundary layer formation and nanoparticle distribution, while a rising electroosmotic term inspires velocity profiles and discourages viscous drag. The ternary hybrid nanofluid augments thermal conductivity, with graphite and CNT propelling thermal dispersion and Al2O3 supporting nanoparticle stability. The findings explain the optimal applications of electrokinetic tuning and MHD parameters in energy harvesting, biomedical microfluidics, and advanced cooling technologies.

**Contributed Talk / 15**

## Development of a hybrid solar clothe-drying system using material and system optimization strategies

**Author:** Yusuf Serah Omolola[1]

**Co-authors:** Emmanuel Etuh [2]; Taiye Ajibola [3]

[1] *Kogi State University kabba*

[2] *Kwararafa University Wukari*

[3] *University of Ilorin*

**Corresponding Author:** lolaobamiro@gmail.com

This research presents, a hybrid solar clothe-drying system developed using material and system optimization strategies. Drying of clothes within the household using electric clothe-dryer could be expensive and time consuming in some densely built urban area around humid tropics, especially in Nigeria where electric power supply is expensive and not regular. With heat pipe and PCM storage unit this challenge was overcome as drying of clothes could be possible at any time of the day. The developed solar clothe-dryer was used to experiment during the indoor and outdoor evaluation performance test which was between July and September 2019, relative-humidity; wind speed, ambient and system temperature were measured. The experimental results were compared with the theoretical results. The maximum and minimum drying rate were 0.512 kg/min and 0.0026 kg/min, while the coefficient of performance was computed to be 0.86 as against the theoretical value of 0.87. The solar clothe-dryer payback period, calculated to be 3.57 years is relatively small compared to a lifespan of 15 years.
KEYWORDS: solar clothes-dryer, thermal-energy, drying-rate, coefficient of performance.

**Contributed talk: Room-2 (Statistics, Biostatistics and Epidemiology) / 41**

## MORPHO-ANATOMICAL STUDIES OF EIGHT SPECIES OF IXORA L. (RUBIACEAE) IN SOUTHWESTERN NIGERIA

**Authors:** Ajoke Sanusi[1]; Oludotun Adewunmi[1]; Temitope Solanke[2]

[1] *Olabisi Onabanjo University*

[2] *University of Ibadan*

**Corresponding Author:** solanketemitope2022@gmail.com

The genus *Ixora* L., a member of the diverse Rubiaceae family, encompasses a range of plant forms from shrubs to small or medium-sized trees. Despite its botanical significance and widespread occurrence, there remains a notable paucity of comprehensive morphological research specifically on *Ixora* species. This research gap has led to widespread misidentification, particularly in regions like Nigeria, where various distinct *Ixora* species are frequently and erroneously identified solely as *Ixora coccinea*. Consequently, accurate species-level differentiation within the genus is often confined to their primary centers of origin.
This study aimed to systematically characterize eight *Ixora* L. species through comprehensive morphological and anatomical evaluations, with the objective of establishing robust identification criteria. Quantitative and qualitative vegetative morphological traits were meticulously recorded using standard measurement tools. Concurrently, quantitative and qualitative anatomical features, including foliar epidermal characteristics, venation patterns, and stomata types, were critically assessed using light microscopy with a calibrated ocular.
Morphological analysis revealed consistent generic traits across all species, such as acute leaf apices, opposite arrangement, attenuate bases, entire margins, and terminal inflorescences, though floral coloration exhibited interspecific variation. All observed morphological and anatomical features demonstrated significant taxonomic utility.
In conclusion, shared morphological characteristics reinforce the grouping of these species within the *Ixora* genus, while distinct interspecies differences in both morphological and anatomical features provide clear and essential criteria for species-level differentiation and identification.
Keywords: *Ixora* L., Morphological characters, Anatomical, Morpho-anatomical study, Rubiaceae, Taxonomic significance
Word count: 237

**Contributed Talk / 28**

## Modelling the Dynamics and Forecasting of Arable Food Prices in Nigeria: A Comparative ARIMA-GARCH Family Approach

**Author:** Akintunde Taiwo[1]

**Co-authors:** Ezekiel Ayoola [1]; Vincent Akinyosoye [1]

[1] *University of Ibadan*

**Corresponding Author:** akintundetaiwo85@gmail.com

Arable food price volatility poses significant challenges to food security, inflation management, and economic stability in Nigeria, demanding robust quantitative forecasting of both price levels and inherent uncertainty. This study employs an econometric framework to model and forecast time-varying volatility in spot prices for two crucial Nigerian arable food commodities: Maize (White) and Rice. Initial analysis revealed strong trends and non-constant variance, leading to natural logarithmic transformation and first-order differencing $(d = 1)$ to achieve stationarity, confirmed by Augmented Dickey-Fuller (ADF) tests. An ARIMA(0,1,0) model, representing a Geometric Random Walk, captured mean dynamics, with residuals serving as market innovations. These residuals then underwent comparative volatility analysis using Symmetric GARCH(1,1), Asymmetric Exponential GARCH (EGARCH(1,1)), and Threshold GARCH (TGARCH(1,1)) models. Model selection leveraged Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), alongside parameter significance. For Maize (White), Symmetric GARCH(1,1) best fit, exhibiting significant ARCH(1) effects $(\alpha[1]p - value < 0.01)$, and implying volatility reacts to recent shocks, quickly reverting to a consistent level without asymmetric effects. For Rice, Symmetric GARCH(1,1) also provided the optimal fit, showing strong IGARCH(1,1) characteristics $(\alpha[1]+\beta[1] \approx 1.0)$ which denote highly persistent volatility shocks that do not decay, also without asymmetric effects. This research uniquely contributes by systematically modelling and forecasting these commodities'time-varying volatility, identifying distinct stochastic dynamics crucial for targeted interventions. It robustly demonstrates that symmetric GARCH models are appropriate, driven primarily by shock magnitude, revealing distinct volatility persistence profiles (ARCH for Maize, IGARCH for Rice). Understanding these precise dynamics empowers stakeholders to quantify future price uncertainty, informing effective

stabilization mechanisms, risk mitigation, and agricultural investment for enhanced food security in Nigeria.

**Contributed Talk / 35**

## Modeling Climate Change and Soil Health Impacts on the Production of Exotic Cayenne Peppers in Coastal Region of Nigeria

**Authors:** Iheoma Adekunle[1]; Ndipmong Udoh[1]

[1] *Federal University Otuoke*

**Corresponding Author:** udohna@fuotuoke.edu.ng

The coastal regions of Nigeria face increasing threats from climate change, including rising temperatures, erratic rainfall patterns, poor soil chemistry and sea-level rise, all of which have profound implications for soil health and agricultural productivity. This study employed advanced climate projection models integrated with soil health simulation tools to assess the potential impacts of climate change with focus on temperature dynamics on the domestication of exotic Cayenne pepper varieties, commonly imported into Bayelsa from other regions of the country due to vulnerable coastal zones. Fluctuations in temperature were correlated with key soil health indicators. The study also utilized crop response models to simulate growth dynamics of selected exotic pepper cultivars under variable environmental stressors. Findings indicate that declining soil quality and rising temperatures could significantly reduce pepper growth performance unless adaptive soil and crop management strategies are implemented. The results emphasize the need for site-specific interventions and climate-resilient agro-based practices to sustain exotic pepper production and ensure food and economic security in Nigeria's coastal agro-ecological zones

**Invited Talk / 45**

## Role of Operations Research and Wargaming in Military Decision Making and Decision Support

**Author:** Altan ÖZKİL[1]

[1] *Atılım University*

**Corresponding Author:** altan.ozkil@atilim.edu.tr

The integration of Operations Research (OR) and Wargaming into military decision-making and decision support systems has become increasingly critical in modern defense strategy and operations. Operations Research plays the synergistic role in enhancing strategic, operational, and tactical decisions. Operations Research provides quantitative analysis and optimization techniques to evaluate complex scenarios, allocate resources efficiently, and predict outcomes. Wargaming, on the other hand, offers a dynamic and interactive environment to simulate real-world combat situations, test hypotheses, and assess the human and organizational factors affecting decisions. The combination of OR's analytical rigor and Wargaming's experiential insights creates a robust framework for military leaders to develop, test, and refine strategies in a controlled yet realistic setting. This dual approach supports decision-making by improving situational awareness, fostering adaptive thinking, and enabling proactive responses to emerging threats. Case studies and historical examples are presented to illustrate the effective application of these tools in military contexts, highlighting their contributions to successful mission planning, execution, and post-action review.

**Contributed Talk / 54**

## Contributed Talk

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