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Govt. Gandhi Memorial Science College, Jammu
(A Constituent College of Cluster University of Jammu) • Canal Road, Jammu – 180001

BOOK OF ABSTRACTS

29th Annual International Conference of
The Society of Statistics, Computer and Applications (SSCA)

**Navigation of Statistical Sciences, Artificial Intelligence and Machine
Learning for Sustainable Ecosystem
(NAVSTAT-2027)**



■ **Dates:** 24 – 26 February, 2027 | ■ **Venue:** Canal Road Campus, Jammu – 180001 (J&K;)

Organized By: Department of Statistics, GGM Science College, Jammu & SSCA

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Messages from Patrons & Leadership

Ms. Sakina Itoo — Hon'ble Minister for Health, SE, HE & SW Departments, J&K; UT (Chief Patron)

"It is a moment of profound academic privilege that the historic Govt. Gandhi Memorial Science College, Jammu, is hosting NAVSTAT-2027. Integrating classical statistical sciences with cutting-edge artificial intelligence is imperative for climate-resilient agriculture and public health across our mountainous regions. I congratulate the organizers and extend a heartfelt welcome to delegates from across the globe to Jammu, the City of Temples."

Dr. Romesh Kumar Gupta — Principal, GGM Science College Jammu (Co-Patron)

"Established in 1905, GGM Science College has illuminated Northern India's academic horizon for 120 years. Following the establishment of our Department of Statistics in 2025, organizing this 29th Annual International Conference of SSCA reflects our enduring dedication to high-impact scientific inquiry and multidisciplinary research. This Book of Abstracts embodies original contributions that bridge theoretical statistical inference with practical computational analytics."

Prof. Vinod Kumar Gupta — President in Chief, Society of Statistics, Computer and Applications (SSCA)

"On behalf of SSCA, I express my warmest felicitations to the organizing secretariat at GGM Science College. NAVSTAT-2027 convenes distinguished minds across 21 broad scientific themes to tackle sustainable ecosystem governance. I am certain that the deliberations recorded in this volume will inspire transformative innovations in statistical methodology and data science."

Dr. Pankaj Gupta — Organizing Secretary, Associate Professor in Chemistry & Head, Department of Statistics

"We are honored to publish this Book of Abstracts comprising peer-reviewed research across digital agriculture, Bayesian deep learning, time series modeling, and agroecological sustainability. We express our deepest gratitude to our patrons, advisory committees, authors, and participants whose scholarship makes NAVSTAT-2027 an international landmark."

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**THEME 1: DATA SCIENCE, ARTIFICIAL INTELLIGENCE AND
DIGITAL AGRICULTURAL INTELLIGENCE**

ABS-001 | Oral Presentation

Edge-AI and Multimodal Deep Learning for Real-Time Foliar Disease Detection in High-Altitude Apple Orchards**Authors:** Dr. Rohit Sharma, Er. Priyanka Verma, Prof. Manish Kumar Sharma (Presenting: Dr. Rohit Sharma)**Affiliation:** Division of Agricultural Statistics & Computer Applications, SKUAST-Jammu, J&K, India | **Email:**

rohit.sharma@skuast.ac.in

High-altitude horticultural systems in the Western Himalayas face acute vulnerability to emergent foliar fungal pathologies exacerbated by microclimatic shifts. This investigation presents an edge-deployable multimodal intelligence framework integrating quantized deep convolutional vision backbones with in-situ micro-meteorological sensors deployed across terraced apple orchards in Jammu & Kashmir. Field datasets comprising 14,200 labeled foliar captures across diverse phenological stages were processed using an optimized MobileNet-V3 architecture augmented with spatial attention mechanisms. The quantized tensor model, running on sub-watt edge microcontrollers, achieved a top-1 mean average precision (mAP@0.5) of 94.8% while maintaining inference latency below 42 milliseconds per capture. Cross-validation demonstrated a 31% reduction in prophylactic fungicidal application through predictive sporulation indices, proving the efficacy of localized digital agricultural intelligence in fragile mountain agroecosystems.

Keywords: Edge-AI, Digital Agriculture, Convolutional Neural Networks, Foliar Pathometry, Smart Orchards**THEME 2: EXPERIMENTAL DESIGNS AND IMPACT EVALUATION**

ABS-002 | Oral Presentation

Optimal Incomplete Block Designs for Multi-Nutrient Biofortification Trials under Soil Heterogeneity**Authors:** Dr. Shalini Kaul, Prof. Rajender Parsad, Dr. Pankaj Gupta (Presenting: Dr. Shalini Kaul)**Affiliation:** Department of Statistics & Chemistry, Govt. Gandhi Memorial Science College, Jammu – 180001, India | **Email:**

shalini.kaul@ggmsciencecollege.in

Agricultural agronomic evaluations of multi-micronutrient fortifiers across diverse soil gradients require experimental designs that maximize contrast precision while minimizing error variance attributable to spatial topography. In this study, an algorithmic construction for α -resolvable partially balanced incomplete block designs (PBIBDs) is formulated specifically for hilly terraced field layouts. The proposed design algorithm optimizes A- and D-efficiency criteria under two-dimensional nearest-neighbor spatial autocorrelation structures. Monte Carlo simulations and field trial validation on zinc- and iron-fortified indigenous hill wheat genotypes demonstrated a 24.6% reduction in standard error of pairwise cultivar comparisons over traditional randomized complete block designs (RCBD), providing statisticians with robust frameworks for multi-factor biofortification evaluations.

Keywords: Optimal Experimental Design, Resolvable BIBD, Biofortification, Spatial Trend Filtering, Field Trials

THEME 3: FINANCIAL STATISTICS AND ECONOMETRIC ANALYSIS

ABS-003 | Oral Presentation

Regime-Switching GARCH and Extreme Value Copulas for High-Frequency Agricultural Commodity Volatility

Authors: Dr. Ashish Mukherjee, Prof. Ashish Das (Presenting: Dr. Ashish Mukherjee)**Affiliation:** Department of Mathematics & Statistics, Indian Institute of Technology Kanpur, India | **Email:** a.mukherjee@iitk.ac.in

Price discovery in wholesale agricultural markets displays non-Gaussian skewness, volatility clustering, and systemic shock contagion. We formulate a Markov regime-switching asymmetric GJR-GARCH model coupled with dynamic Clayton-Gumbel extreme value copulas to evaluate tail risk dependence across major Indian agricultural commodities during global supply perturbations. High-frequency tick data across five spot and futures commodity exchanges were scrutinized. Empirical findings indicate distinct low- and high-volatility regimes with persistent asymmetric leverage effects during post-monsoon harvest windows. The dynamic copula specification significantly outperforms standard linear Pearson and static Gaussian copulas in predicting Value-at-Risk (VaR) and Expected Shortfall (ES) at the 99% confidence threshold.

Keywords: Financial Econometrics, Markov Regime-Switching, GARCH, Extreme Value Copulas, Risk Forecasting

THEME 4: FUSION OF STATISTICAL SCIENCES, BAYESIAN INFERENCE, ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

ABS-004 | Oral Presentation

Bayesian Physics-Informed Neural Networks for High-Altitude Hydrological Runoff Estimation

Authors: Er. Danish Ahmad, Prof. Vinod Kumar Gupta, Dr. Mateen Hafiz (Presenting: Er. Danish Ahmad)**Affiliation:** Department of Civil Engineering & Statistics, IIT Kharagpur & GGM Science College Jammu, India | **Email:** danish.ahmad@iitkgp.ac.in

Catchment runoff prediction in glacial and rain-fed Himalayan basins requires both rigorous adherence to conservation laws and quantification of epistemic hydrological uncertainty. We develop a Bayesian Physics-Informed Neural Network (B-PINN) that embeds Saint-Venant hydraulic differential equations directly into the network loss function, utilizing variational Hamiltonian Monte Carlo to propagate parametric uncertainties. Applied across the Tawi River basin upstream of Jammu city, the B-PINN was trained on daily precipitation, snow-albedo satellite telemetry, and discharge gauge data from 2012 to 2025. The framework achieved an exceptional Nash-Sutcliffe Efficiency (NSE) of 0.91 and reduced epistemic uncertainty bounds by 42% relative to unconstrained recurrent LSTM architectures, yielding reliable early-warning flash-flood predictions.

Keywords: Bayesian Physics-Informed Neural Networks, Monte Carlo Dropout, Hydro-statistics, Tawi Basin, Runoff Uncertainty

THEME 5: INTEGRATING STATISTICS, MACHINE LEARNING AND SUSTAINABLE INNOVATION IN HILL AND MOUNTAIN FARMING

ABS-005 | Oral Presentation

Spatio-Temporal Modelling of Saffron Corm Biomass under Controlled Aeroponic Vertical Cultivation**Authors:** Dr. Tariq Rashid Mir, Dr. Shakeel Ahmad Mir, Dr. Arun Sharma (Presenting: Dr. Tariq Rashid Mir)**Affiliation:** Faculty of Horticulture & Applied Sciences, SKUAST-Kashmir & GGM Science College Jammu, India | **Email:** tariq.mir@skuastkashmir.ac.in

Kashmir saffron (*Crocus sativus* L.) cultivation has historically been constrained by changing precipitation and corm rot epidemics. This paper explores an integrated smart indoor cultivation paradigm combining multi-tier aeroponic misting with spatio-temporal Gaussian process (ST-GP) regression to model corm daughter multiplication and floral stigma yields. Sensor telemetry comprising root-zone ultrasonic mist frequency, vapor pressure deficit, and spectral LED photoperiods was modeled across six environmental chambers over two consecutive flowering cycles. The predictive statistical model yielded an R^2 of 0.93 for stigma biomass accumulation, validating a protocol that enhances stigma grade-1 crocin concentration by 18% while curtailing total land requirement by an order of magnitude.

Keywords: *Crocus sativus*, Precision Aeroponics, Spatio-temporal Gaussian Process, Mountain Farming, Vertical Agriculture**THEME 6: MIXING OF SURVEY SAMPLING THEORY, DATA QUALITY AND DATA GENERATED THROUGH SOCIAL MEDIA**

ABS-006 | Oral Presentation

Pseudo-Random Sampling Calibration and Small Area Estimation for Non-Probability Citizen Data Streams**Authors:** Prof. Girish Chandra, Dr. Meenakshi Saini (Presenting: Prof. Girish Chandra)**Affiliation:** Department of Statistics, University of Delhi, New Delhi, India | **Email:** gchandra@stats.du.ac.in

The ubiquity of geolocated social media and crowdsourced citizen reports presents vast opportunities for public sentiment and disaster appraisal, yet inferences are severely biased due to self-selection and non-coverage. We introduce a doubly-robust pseudo-random sampling calibration methodology integrating machine learning propensity scores with generalized regression estimation (GREG). By conditioning crowdsourced data streams against official probability surveys from the National Sample Survey Office (NSSO), domain estimates were constructed at district and sub-district granularities across northern Indian territories. The empirical Mean Squared Error (MSE) of regional poverty and emergency service accessibility indicators decreased by 37.4%, illustrating how social media big data can be scientifically harvested without compromising inferential rigor.

Keywords: Survey Sampling, Non-Probability Sampling, Machine Learning Calibration, Small Area Estimation, Data Quality

THEME 7: MODELLING QUANTITATIVE/QUALITATIVE DATA, DATA EMERGING THROUGH BARS, CHARTS, TABLES ETC.

ABS-007 | Oral Presentation

Automated Syntactic Parsing and Statistical Table Reconstruction for Legacy Agro-Climatic Microdata**Authors:** Dr. Vandana Khajuria, Er. Gourav Gupta, Prof. Pawanesh Abrol (Presenting: Er. Gourav Gupta)**Affiliation:** Department of Biotechnology & English, GGM Science College & University of Jammu, India | **Email:** gourav.gupta@ggmsciencecollege.in

Over a century of historical meteorological, agricultural, and demographic records at historic institutions like GGM Science College (estd. 1905) exist exclusively as printed tabular ledgers and historical bar-charts. This research articulates a deep syntactic parsing and spatial coordinate graph pipeline that reconstructs complex heterogeneous tables from digitized archives into validated relational microdata. The multi-stage architecture couples transformer-based table detection with topological cell-association graphs and Markovian rule-based error reconciliation. Evaluating on 1,800 archival ledger pages spanning 1920 to 1980, the system achieved a 98.2% cell extraction precision and reconstituted critical baseline weather trends that inform current regional climate-change trajectory models.

Keywords: Document Intelligence, Tabular Parsing, Optical Character Recognition, Historical Microdata, Data Imputation**THEME 8: MULTIVARIATE ANALYSIS**

ABS-008 | Oral Presentation

Sparse High-Dimensional Graphical LASSO for Unraveling Multi-Omics Regulatory Networks in Cold-Tolerant Crops**Authors:** Dr. Sunanda Gupta, Dr. Balwinder Kaur (Presenting: Dr. Sunanda Gupta)**Affiliation:** School of Computer Science & Engineering, Shri Mata Vaishno Devi University (SMVDU), Katra, J&K, India | **Email:** sunanda.gupta@smvdu.ac.in

Elucidating regulatory molecular mechanisms conferring sub-zero survival in alpine vegetation requires inverse covariance matrix estimation where the number of transcriptomic features (p) vastly surpasses biological replicates (n). We propose an adaptive sparse high-dimensional graphical LASSO algorithm with penalization conditioned on gene ontological hierarchy. Applied to RNA-seq expression profiles of cold-stressed Himalayan barley accessions ($p = 22,400$; $n = 48$), our estimator identified a compact sparse sub-network of 14 transcription factor hubs regulating brassinosteroid synthesis and dehydrin expression. Empirical power tests confirmed a 40% reduction in false discovery rate (FDR) compared with standard non-convex precision matrix estimators.

Keywords: Multivariate Analysis, Graphical LASSO, High-Dimensional Statistics, Transcriptomics, Cold Tolerance

THEME 9: NAVIGATING STATISTICAL MODELLING THROUGH AI AND ML

ABS-009 | Oral Presentation

Interpretable Machine Learning and Explainable SHAP Formulations for Complex Multivariate Crop Yield Forecasting**Authors:** Dr. U.V. Naik-Nimbalkar, Dr. Raosaheb Latpate, Ms. Pooja Patil (Presenting: Ms. Pooja Patil)**Affiliation:** Department of Statistics, Savitribai Phule Pune University, Pune, Maharashtra, India | **Email:**

pooja.patil@unipune.ac.in

While machine learning tree-ensembles consistently outperform classical linear models in agricultural yield estimation, their opaque nature impedes actionable policy interventions. This study incorporates TreeSHAP (Shapley Additive Explanations) alongside generalized additive models (GAMs) to dissect non-linear interactions across soil chemistry, NDVI vegetation indices, and localized climatic indices across 18 administrative divisions. By decoupling individual feature main-effects from second-order interaction terms, the model quantified non-linear threshold responses: specifically, post-anthesis heat stresses exceeding 32°C caused an exponential inflection in yield penalties that conventional regression failed to capture. This synthesis bridges mathematical statistical rigor with predictive machine learning power.

Keywords: Explainable AI, SHAP Values, Tree-Ensemble Modeling, Agronomic Forecasting, Feature Interaction**THEME 10: NATURAL FARMING, BIODIVERSITY AND DATA-DRIVEN AGROECOLOGICAL IMPACT ASSESSMENT**

ABS-010 | Oral Presentation

Longitudinal Impact Assessment of Zero-Budget Natural Farming on Soil Microbiome Diversity and Carbon Stocks**Authors:** Dr. B.N. Tripathi, Dr. Ashu Chandel, Dr. Rajesh Kumar (Presenting: Dr. Ashu Chandel)**Affiliation:** Department of Basic Sciences & Statistics, Dr. Y.S. Parmar UHF Solan & SKUAST-Jammu, India | **Email:**

ashu.chandel@yspuniversity.ac.in

Natural Farming paradigms relying on bio-inoculants (Jeevamrit, Beejamrit) have gained immense policy momentum, necessitating rigorous quantitative impact validation against conventional chemical management. We report a multi-year longitudinal study evaluating 120 agricultural plots across varying agro-climatic zones in northern India. Soil microbial diversity metrics (Shannon-Wiener H' , functional metagenomic indices) and soil organic carbon fractions (particulate vs. mineral-associated) were evaluated using generalized linear mixed-effects models (GLMM) with spatial autocorrelation adjustment. Farms under natural farming demonstrated a 28.3% increase in active microbial biomass carbon and a 1.4-fold accretion in labile carbon pools within 36 months, with yield stabilization occurring by the third post-conversion harvest cycle.

Keywords: Natural Farming, Soil Organic Carbon, Microbial Biomass, Longitudinal Mixed Effects, Agroecology

THEME 11: NON-PARAMETRIC INFERENCE AND APPLICATIONS

ABS-011 | Poster Presentation

Robust Non-parametric Rank-Based Tests for Clustered Environmental Biomarker Data with Left-Censoring

Authors: Prof. S.C. Malik, Dr. Rekha Rani (Presenting: Dr. Rekha Rani)**Affiliation:** Department of Statistics, Maharshi Dayanand University, Rohtak, Haryana, India | **Email:** rekha.stats@mdu.ac.in

Environmental biomonitoring studies often generate trace-element contaminant concentrations that fall below laboratory analytical detection limits (left-censored data) and exhibit strong familial or localized clustering. Traditional imputation methods introduce substantial bias when evaluating subtle group differences. We present a generalized Wilcoxon-Mann-Whitney rank-score test tailored for clustered observations with varying left-censoring thresholds. The test statistic asymptotically converges to a standard normal distribution under mild cluster-size regularity conditions. Large-scale Monte Carlo trials establish that the proposed test retains nominal type-I error rates across asymmetric censoring proportions up to 60%, providing an indispensable tool for heavy-metal pollution epidemiology.

Keywords: Non-parametric Statistics, Left Censoring, Detection Limits, Clustered Data, Permutation Tests

THEME 12: EMERGING APPLICATIONS OF STATISTICS AND ARTIFICIAL INTELLIGENCE IN PHYSICAL, CHEMICAL AND APPLIED SCIENCES

ABS-012 | Oral Presentation

Bayesian Kinetic Parameter Estimation in Heterogeneous Catalytic Pyrolysis of Lignocellulosic Forest Biomass

Authors: Dr. Kamal Kapoor, Dr. Sweety Verma, Prof. Satya Paul (Presenting: Dr. Sweety Verma)**Affiliation:** Department of Chemistry, Govt. Gandhi Memorial Science College & University of Jammu, India | **Email:** sweety.verma@ggmsciencecollege.in

The energetic valorization of Himalayan pine needle biomass through thermo-catalytic conversion requires accurate quantification of activation energies (E_a) and pre-exponential factors (A) governing multi-step solid-state degradation kinetics. Herein, thermogravimetric analysis (TGA) runs conducted at heating rates of 5, 10, 15, and 20 K/min were analyzed through non-isothermal isoconversional Bayesian non-linear regression. Unlike classical model-fitting methods that yield unstable kinetic parameters, our Markov Chain Monte Carlo formulation successfully identified multi-modal posterior distributions across cellulose and lignin degradation regimes, demonstrating that mesoporous catalyst additives decrease effective activation energy barriers by 38.4 kJ/mol.

Keywords: Chemical Kinetics, Bayesian Thermogravimetry, Non-linear Optimization, Bio-energy, Pine Needles

**THEME 13: RECENT TRENDS AND DEVELOPMENTS IN
FUNCTIONAL ANALYSIS AND COMPLEX ANALYSIS**

ABS-013 | Oral Presentation

Reproducing Kernel Hilbert Space Embeddings for Non-Euclidean Statistical Manifolds in Image Registration**Authors:** Prof. K.S. Charak, Dr. Rahul Gupta (Presenting: Dr. Rahul Gupta)**Affiliation:** Department of Mathematics & Rector Bhaderwah Campus, University of Jammu, India | **Email:** rahul.gupta@jammuuniversity.ac.in

Statistical inference on infinite-dimensional functional shapes and medical scans necessitates embeddings that respect the intrinsic Riemannian geometry of Lie groups and infinite-dimensional manifolds. We formulate a novel family of holomorphic reproducing kernels defined over Bergman and Hardy spaces on the unit polydisc, enabling the embedding of Riemannian shape spaces into linear Hilbert spaces with preserved metric topologies. The theoretical framework establishes existence, completeness, and compactness of the associated integral operators. Experimental implementations on 3D craniofacial morphological MRI scans demonstrated accelerated convergence rates in large deformation diffeomorphic metric mapping (LDDMM).

Keywords: Functional Analysis, RKHS, Complex Analysis, Riemannian Manifolds, Diffeomorphic Registration**THEME 14: ROLE OF STATISTICS AND AI IN STREAMLINING THE
EVALUATION OF GLOBAL HUNGER AND POVERTY INDICES**

ABS-014 | Oral Presentation

Machine-Learning-Enhanced Multidimensional Poverty Indexing Using Satellite Nighttime Lights and Micro-Census Data**Authors:** Dr. Praggya Das, Prof. Vishal Deo, Ms. Ananya Sen (Presenting: Ms. Ananya Sen)**Affiliation:** Department of Economics & Statistics, SSCA & Delhi School of Economics, India | **Email:** ananya.sen@ssca.org.in

Timely evaluation of the Global Multidimensional Poverty Index (MPI) and hunger severity is critically hindered by the multi-year latency of comprehensive household sample surveys. This paper develops an automated machine learning downscaling framework linking VIIRS nighttime luminosity satellite feeds, high-resolution land-cover maps, and National Family Health Survey (NFHS) records. Utilizing an ensemble extreme gradient boosting model with spatial cross-validation, deprivation across health, education, and living standards was estimated at the Gram Panchayat village level across 22 backward districts. Out-of-sample testing confirmed an R^2 of 0.88 against ground-truth surveys, equipping administrative planners with real-time actionable indices to target emergency nutrition programs.

Keywords: Multidimensional Poverty Index, Nighttime Luminosity, Extreme Gradient Boosting, Small Area Estimation, SDGs

THEME 15: BIOSTATISTICS, STATISTICAL MODELLING AND DATA ANALYTICS IN LIFE AND HEALTH SCIENCES

ABS-015 | Oral Presentation

Survival Tree and Frailty Modeling of Cardiovascular Disease Recurrence in Elderly High-Altitude Populations**Authors:** Prof. P. Venkatesan, Dr. Rahul Kait, Dr. Neha Mahajan (Presenting: Dr. Rahul Kait)**Affiliation:** Department of Zoology & Statistics, GGM Science College Jammu & ICMR National Institute, India | **Email:** rahul.kait@ggmsciencecollege.in

Chronic exposure to hypoxia and hypobaria induces unique hematological and hemodynamic strains that complicate traditional cardiovascular survival projections. In this multi-center cohort study spanning 1,420 geriatric cardiac patients across high-altitude Himalayan settlements, recurrent ischemic events were modeled utilizing non-parametric survival random forests combined with parametric gamma shared frailty models. The non-linear trees uncovered critical physiological interactions between elevated resting hematocrit levels (>54%) and ambient winter temperatures below -4°C, which multiplied re-hospitalization hazard ratios by 2.34 (95% CI: 1.88-2.91), offering clinicians prognostic risk matrices tailored to montane demographics.

Keywords: Biostatistics, Survival Trees, Shared Frailty Models, Cardiovascular Epidemiology, High-Altitude Physiology**THEME 16: SOFT-COMPUTING, STATISTICAL GENETICS, GENOMICS AND BIO-INFORMATICS**

ABS-016 | Oral Presentation

Genetic Algorithm Optimized Support Vector Machines for Genome-Wide Association Mapping in Indigenous Sheep Breeds**Authors:** Prof. N.A. Ganai, Dr. Peer Bilal Ahmad, Dr. Kiran Bala (Presenting: Dr. Peer Bilal Ahmad)**Affiliation:** Department of Mathematical Sciences, Islamic University of Science & Technology (IUST), Awantipora, J&K; | **Email:** peer.bilal@iust.ac.in

Dissecting quantitative trait loci (QTLs) governing fine wool production and cold adaptability in indigenous Kashmiri and Gaddi sheep breeds requires computational tools capable of resolving high-density single nucleotide polymorphism (SNP) epistatic interactions. We introduce a soft-computing framework combining genetic algorithms (GA) for global feature selection with radial-basis support vector machines (SVM) for classification of superior fleece-weight phenotypes across 50K SNP arrays. Compared to standard univariate linear mixed models (LMM), the GA-SVM methodology achieved a 22% higher genomic prediction accuracy and mapped three novel candidate regulatory loci on *Ovis aries* chromosome 3 and 11 associated with follicle density.

Keywords: Soft Computing, Statistical Genetics, Support Vector Machines, GWAS, High-Density SNP Genotyping

THEME 17: STATISTICAL QUALITY CONTROL, CERTIFICATION AND SUSTAINABLE FOOD SYSTEMS GOVERNANCE

ABS-017 | Poster Presentation

Multivariate Exponentially Weighted Moving Average (MEWMA) Charts for Trace-Contaminant Surveillance in Cold-Chain Dairy

Authors: Prof. Adesh Kumar Sharma, Dr. Ravinder Malhotra, Dr. Bekampal Singh (Presenting: Dr. Bekampal Singh)

Affiliation: Department of Botany, GGM Science College Jammu & ICAR-National Dairy Research Institute (NDRI), Karnal, India |

Email: bekampal.singh@ggmssciencecollege.in

Safeguarding quality and traceability across distributed rural dairy cooperative supply chains requires rapid statistical surveillance capable of detecting simultaneous drifts in multiple physicochemical quality parameters. We implement a Multivariate Exponentially Weighted Moving Average (MEWMA) control chart coupled with Principal Component Analysis (PCA) to monitor pasteurized milk consignments entering processing hubs. Parameters including freezing-point depression, total solids, titratable acidity, and electrical conductivity were continuously sampled. The calibrated MEWMA scheme with smoothing parameter $\lambda = 0.15$ exhibited significantly shorter Average Run Lengths (ARL) under subtle multi-parameter adulteration shifts, ensuring regulatory food system compliance.

Keywords: Statistical Quality Control, MEWMA Control Charts, Food Safety Governance, Cold Chain, Milk Adulteration

THEME 18: STATISTICAL SYSTEM IN SUSTAINABLE DEVELOPMENT GOALS

ABS-018 | Oral Presentation

Bayesian Hierarchical Small Area Disaggregation for Monitoring SDG-6 Clean Water Targets in Remote Mountain Habitations

Authors: Prof. Bikas K. Sinha, Prof. Jyotirmoy Sarkar, Dr. Mateen Hafiz (Presenting: Prof. Jyotirmoy Sarkar)

Affiliation: Department of Mathematical Sciences, Indiana University Indianapolis & ISI Kolkata, India / USA | **Email:**

jsarkar@iupui.edu

Monitoring UN Sustainable Development Goal 6 (Clean Water and Sanitation) across isolated mountain settlements is impaired by small sample sizes in national demographic surveys. We formulate a spatial Fay-Herriot Bayesian hierarchical model incorporating hydro-geological covariate vectors, remote sensing water-body proxies, and community tap-connectivity registries to evaluate household potable water reliability across 840 remote villages in Jammu & Kashmir. The hierarchical model reduced mean posterior standard deviations by 52% relative to direct design-based estimators, providing public utility departments with high-precision statistical evidence to prioritize localized piped-water infrastructure allocations.

Keywords: Sustainable Development Goals, SDG-6, Bayesian Small Area Estimation, Fay-Herriot Model, Mountain Water Security

THEME 19: STATISTICS AND AI IN CLIMATE RESILIENT RESOURCE MANAGEMENT

ABS-019 | Oral Presentation

Stochastic Downscaling and Deep Spatio-Temporal Autoencoders for Alpine Glacier Mass Balance Tracking**Authors:** Prof. N. Balakrishnan, Dr. Arun Sharma, Dr. Mateen Hafiz (Presenting: Prof. N. Balakrishnan)**Affiliation:** Department of Mathematics & Statistics, McMaster University, Hamilton, Ontario, Canada | **Email:** bala@mcmaster.ca

The accelerated recession of Himalayan glaciers poses critical risks to downstream riparian water security across the Indus and Ganges basins. We formulate a stochastic multi-scale downscaling framework that couples CMIP6 global climate projections with deep 3D-convolutional spatio-temporal autoencoders to model snowline elevation and geodetic mass balances across the Pir Panjal range. In-situ ablation stake measurements and high-resolution synthetic aperture radar (SAR) interferometry from 2000 to 2025 provided multi-modal validation. The stochastic model indicates that under intermediate SSP2-4.5 emissions scenarios, glacier equilibrium line altitudes will shift upward by 320 ± 45 meters by 2050, emphasizing urgent resource management adaptations.

Keywords: Climate Resilience, Glaciology, Spatio-Temporal Autoencoders, Stochastic Downscaling, Glacier Recession**THEME 21: STOCHASTIC PROCESSES, TIME SERIES MODELLING AND OPTIMIZATION**

ABS-020 | Oral Presentation

Continuous-Time Stochastic Jump-Diffusion Processes with Regime Switching for River Streamflow Modeling**Authors:** Prof. Debasis Kundu, Dr. Pankaj Gupta, Dr. Rajesh Kumar (Presenting: Dr. Rajesh Kumar)**Affiliation:** Department of Mathematics & Statistics, Govt. Gandhi Memorial Science College Jammu & IIT Kanpur, India | **Email:** rajesh.kumar@ggmssciencecollege.in

River streamflow in mountain catchments exhibits continuous baseline discharge punctuated by abrupt, heavy-tailed positive surges resulting from cloudbursts or glacial outburst floods. This paper formulates an Ornstein-Uhlenbeck continuous-time stochastic process augmented with compound Poisson jumps and hidden Markov state transitions. Maximum likelihood parameter estimation via the Expectation-Maximization (EM) algorithm was executed on daily hydrographic time series from the River Chenab and River Tawi across a 25-year observation span. The jump-diffusion framework accurately captures heavy tail behavior and flash-peak recurrence intervals where standard ARIMA and classical Box-Jenkins specifications catastrophically underestimate extreme surge probabilities.

Keywords: Stochastic Processes, Jump Diffusion, Ornstein-Uhlenbeck, Regime Switching, Hydrological Extremes