

Collective Sciences and Sustainability: Integrating AI, Resource Optimization, and Societal Welfare

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The rapid evolution of sustainable development strategies, collective sciences, and digital infrastructure continues to reshape the way we manage resources, optimize ecological systems, and build resilient communities.^[1] Nowadays, the convergence of these paradigms with artificial intelligence (AI), machine learning (ML), and advanced engineering is enabling innovative, data-driven solutions across energy footprint management, environmental engineering, public safety, and social welfare systems.^[2] As these technologies advance, interdisciplinary research remains essential for translating computational models and scientific insights into practical, scalable, and impactful sustainable applications.^[3]

The *Journal of Collective Sciences and Sustainability* (Volume 2, Issue 3) consists of seven articles from rapidly growing fields, with research spanning energy-constrained artificial intelligence, smart system security evaluation, ecological wastewater treatment, predictive water resource analytics, thermal engineering, centralized web platforms for community welfare, and geospatial crime forecasting.

In this present issue, Balaselvakumar and Santhi provides a systematic review synthesizing 29 evidence units from 46 publications to address the fragmented landscape of predictive policing and geospatial artificial intelligence (GeoAI) in India. The authors critically evaluate traditional spatial methods alongside advanced machine-learning and deep-learning approaches, identifying critical limitations in the existing literature such as a heavy reliance on retrospective hotspot mapping, a lack of independent replication, and weak reporting of data provenance. By proposing an integrated evidence framework that separates descriptive spatial evidence from predictive claims, this study establishes six strategic research priorities, including bias auditing, climate-crime integration, and cross-state benchmarking, to foster more transparent, reproducible, and context-sensitive GeoAI systems within public administration.^[4] Parnika Thakur presents an energy-aware, software-oriented architecture designed to limit the energy consumption of local Information and Communication Technology (ICT) infrastructure and prolong the lifetime of legacy enterprise hardware. The system utilizes request-based model cascades and an emergency load-based admission control module to dynamically manage model complexity and inference accuracy during periods of high computational workload. Evaluated via trace-driven numerical experiments on the Alibaba Cluster Trace,

the study demonstrates that retaining legacy enterprise hardware significantly reduces net lifecycle carbon emissions compared to premature replacement on energy grids with abundant renewables.^[5] Mukadam *et al.* present a 3-layer system evaluation framework designed to address the "local optimization fallacy" in smart city emergency response systems, where narrow optimization of location precision often degrades overall battery life and alert reliability. Evaluating the framework through a simulated prototype Smart Tourist Safety Monitoring System across 500 tourist trajectories and 2,126 synthetic alert events, the study demonstrates that replacing constant GPS polling with adaptive geofencing reduces simulated GPS energy consumption by 83.5%. Furthermore, by integrating a temporal SMS fallback and a human-in-the-loop cancellation mechanism, the proposed multilayer optimization yields a 27.7% overall reduction in false-alarm escalations, confirming that balanced multidimensional design consistently outperforms single-metric maximization in resource-constrained Internet of Things (IoT) deployments.^[6] Afeez Oladeji Amoo evaluates a hybrid Coconut-Shell-Derived Biochar (CSDB) membrane system coupled with machine learning models to predict and optimize pollutant removal and membrane fouling in agro-processing mill wastewater treatment. Utilizing a two-stage experimental design, the study trains multiple algorithms, finding that XGBoost and Artificial Neural Network (ANN) models deliver the highest predictive accuracy with test-set R^2 values ranging from 0.91 to 0.96. Ultimately, multi-objective optimization determines that a CSDB dosage of 12–15 g/L, a contact time of 90–105 minutes, and a transmembrane pressure of 1.0–1.1 bar achieve maximum pollutant removal while reducing fouling resistance by 35–45%, offering a highly cost-effective and sustainable pathway for treating agricultural effluents.^[7] Twenefour *et al.* present a methodological simulation study investigating validation pitfalls, specifically target circularity and optimistic within-domain validation, that artificially inflate machine learning performance when predicting the Water Quality Index (WQI). Evaluating XGBoost, Random Forest, linear, and Ridge regression models across a synthetic 150-record benchmark generated for the Birim, Offin, and Pra sub-basins, the authors demonstrate that full-feature models drop to negative R^2 values upon the removal of index-defining variables. Furthermore, the models exhibit exceptionally weak geographic transferability, with out-of-basin XGBoost performance plunging between -0.078 and -22.982, highlighting that strong local predictive capabilities can coexist with poor regional generalizability regardless of whether linear or tree-based algorithms are deployed.^[8] Tummalapalli *et al.* conducted an experimental and computational investigation into a 204 mm copper–water heat pipe

equipped with a stainless-steel mesh wick to optimize small-scale passive thermal management systems. Utilizing ANSYS steady-state thermal simulations alongside laboratory testing, the study evaluates temperature distributions, thermal resistance, and phase-change characteristics, comparing a copper-walled system against a stainless steel 304 (SS304) equivalent. The copper heat pipe achieved a conduction-based heat-transfer rate of 31.15 W and a low thermal resistance of 1.605 K/W, whereas the SS304 alternative exhibited a significantly higher thermal resistance of 42.4 K/W, confirming the structural superiority of copper-water systems for high-performance, compact cooling applications.^[9] Shaikh *et al.* present the design and evaluation of RescueTails, a full-stack web application built on the MERN (MongoDB, Express.js, React.js, Node.js) technology stack, to address the fragmented nature of urban animal welfare and stray rescue coordination. The centralized digital platform streamlines the reporting of distressed animals, coordinates adoption workflows, and enables structured resource allocation between citizens, NGOs, veterinary services, and foster homes. JMeter-based benchmark load testing and functional verification demonstrate stable performance and subsecond API latency under evaluated conditions, showcasing the operational feasibility of scalable social-impact technology in addressing gaps in urban community infrastructure.^[10]

In conclusion, this issue underscores the vital role that computational optimization, robust validation frameworks, and centralized digital infrastructures play in advancing global sustainability. By bridging the gap between theoretical data science and field-specific applications, whether in energy grids, water basins, thermal management, or urban safety networks these studies demonstrate that sustainable development cannot rely on isolated technical metrics. Instead, true progress requires a holistic, collective approach that harmonizes technological innovation with socio-technical resilience and ecological responsibility.

Conflict of Interest

There is no conflict of interest.

Artificial Intelligence (AI) Use Disclosure

The author declare that artificial intelligence (AI)-assisted tools were used only for language refinement, grammar improvement, and manuscript structuring purposes during the preparation of this work. All content and interpretations were reviewed and verified by the author.

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