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Editorial

Editorial: INSPIRE—Improving Nature-Smart Policies Through Innovative Resilient Evaluations

Pierfrancesco De Paola [1,*], Francesco Tajani [2] and Francesco Sica [2]

[1] Department of Industrial Engineering, University of Naples "Federico II", Vincenzo Tecchio Sq. 80, 80125 Naples, Italy
[2] Department of Architecture and Design, Sapienza University of Rome, Via Flaminia 359, 00196 Rome, Italy; francesco.tajani@uniroma1.it (F.T.); francesco.sica@uniroma1.it (F.S.)
* Correspondence: pierfrancesco.depaola@unina.it

Abstract

The real estate appraisal sector is undergoing a profound transformation, shifting from traditional financial metrics toward multidisciplinary approaches that integrate civil engineering, territorial and environmental analysis, and advanced econometric modeling. This evolution addresses the hidden risks in so-called "zombie assets" and supports sustainable investment decisions. The INSPIRE Open Topic explores innovative methodologies to translate qualitative aspects—such as governance, environmental exposure, and social equity—into robust quantitative frameworks for both private and public decision-making. Fuzzy logic has emerged as a key tool for quantifying qualitative judgments, enhancing the transparency and reliability of ESG assessments. Empirical evidence shows that these approaches provide a realistic representation of risk, guide resilient urban strategies, and lay the foundation for scalable, sustainable, and transparent real estate evaluation.

Keywords: mass appraisal methods; econometric models; real estate risk management; ESG; urban economics; real estate investments economic valuation; environmental economic

1. Introduction

The global field of real estate appraisal is undergoing a profound transformation, prompted by a growing awareness that conventional financial metrics are no longer sufficient for capturing the qualitative risks embedded in contemporary urban development. This transition marks a shift from a narrow emphasis on short-term cash flows toward a more advanced, multidisciplinary approach that integrates civil engineering expertise, environmental and spatial analysis, and econometric modeling. From a strategic consultancy standpoint, this evolution represents a necessary response to the rise of so-called "zombie assets"—properties that appear economically sound under traditional valuation frameworks but conceal significant systemic vulnerabilities related to inadequate environmental management and an exposure to climate risks.

Within this evolving context, appraisal practices are increasingly adopting a forward-looking paradigm in which engineering-based knowledge, territorial–environmental assessments, and advanced computational techniques play a central role. This emerging framework prioritizes an asset's ability to retain value over time by responding effectively to regulatory changes, environmental constraints, and societal expectations. Valuation is therefore no longer viewed solely as a technical procedure, but rather as a strategic instrument capable of steering sustainable investment choices and informing urban policy.

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The Open Topic INSPIRE—Improving Nature-Smart Policies through Innovative Resilient Evaluations is firmly embedded within this paradigm shift. By bringing together contributions that reinterpret real estate appraisal through the lenses of sustainability, resilience, and decision support, this collection demonstrates how innovative methodologies can translate qualitative dimensions—such as governance quality, environmental exposure, and social equity—into structured and operational quantitative frameworks. With this perspective, particular attention is devoted to the integration of fuzzy logic techniques, which allow for the treatment of uncertainty, ambiguity, and partial truth conditions that typically characterize environmental and socio-economic evaluations. Through fuzzy set theory and linguistic variables, complex and imprecise information can be formalized without forcing artificial crisp boundaries, thus preserving the richness of expert judgments and stakeholder perceptions. By incorporating fuzzy-based multi-criteria decision models, the proposed approaches enhance our capacity to manage heterogeneous datasets and conflicting objectives, improving transparency and robustness in evaluation outcomes. These methodologies are designed to support both private investment decisions and public-sector strategies, fostering more adaptive, inclusive, and evidence-informed policy frameworks.

Section 2 presents a summary of the 13 selected papers, while Section 3 discusses the main insights and thematic reflections emerging from their collective contribution. Finally, Section 4 outlines future research directions, identifying potential avenues for further investigation.

2. INSPIRE Content Analysis

The INSPIRE Open Topic brings together 13 contributions, summarized below, based on research conducted between 2024 (1 paper) and 2025 (12 papers). The papers were published in the journals Buildings (ISSN: 2075-5309), Land (ISSN: 2073-445X), Real Estate (ISSN: 2813-8090), and Sustainability (ISSN: 2071-1050).

Cai et al. [1] introduce an intelligent ESG (Environmental, Social, and Governance) assessment framework for the Chinese construction industry, a sector with high emissions and safety risks. The approach combines Large Language Models (LLMs) and machine learning techniques, including XGBoost, to automatically extract data from sustainability reports and generate more objective corporate ratings. SHAP analysis is used to identify the key drivers of ESG scores, while Knowledge Graphs enhance data coherence. The framework provides a transparent, data-driven decision support tool to improve sustainability performance and support China's 2060 carbon neutrality goal.

Sica et al. [2] develop a spatial–temporal ontology to classify urban sustainability indicators in line with international ISO standards. Based on an extensive literature review, more than 500 indicators are organized into economic, social, and environmental dimensions. Using Italy as a test case, the study demonstrates how indicators can be consistently mapped across spatial scales—from neighborhoods to macro-regions—while ensuring temporal reliability. The framework supports policymakers in monitoring progress toward the 2030 Agenda.

Fiorentini et al. [3] present a probabilistic model to assess the financial feasibility of urban regeneration projects, balancing private profitability and public interest. Monte Carlo simulations applied to three case studies in the Municipality of Lucca estimate land transformation values under uncertainty in costs and market conditions. Comparing uniform and normal distributions, the study shows that probabilistic methods outperform deterministic approaches in risk management and planning calibration, supporting public strategies that enhance ecosystem services and public spaces.

Di Liddo et al. [4] analyze the relationship between quality of life and real estate market dynamics across 107 Italian provincial capitals. Using statistical analysis and GIS,

the study examines how income, employment, safety, and service availability influence housing prices and transaction volumes. Their results highlight a strong link between socio-economic well-being and real estate values, as well as marked territorial disparities between Northern and Southern Italy.

Locurcio et al. [5] propose a framework for integrating environmental risk into real estate investment appraisals. By monetizing seismic, hydrogeological, and pollution risks, the study defines a more robust and transparent risk premium, addressing the limits of traditional financial models. The harmonization of heterogeneous risk metrics supports investors and public authorities in promoting territorial resilience and sustainable urban development.

Tavano et al. [6] address the decarbonization of the Italian housing stock, focusing on the gap between the goals of the European "Green Homes" directive (EPBD) and household financial capacity. The Retrofit Optimization Problem (ROP), inspired by the multidimensional knapsack problem, simulates the affordability of energy retrofitting measures across income groups. The results show that over 40% of households cannot afford the most effective interventions, highlighting the risk of increased inequality without income-sensitive incentives.

Andrade and Almeda [7] explore intra-urban real estate cycles in Belo Horizonte, Brazil, challenging the assumptions of homogeneous metropolitan markets. Using the SKATER algorithm, the city is divided into six endogenous spatial regimes with distinct and asynchronous price dynamics. The analysis reveals the differentiated impacts of economic cycles across neighborhoods, underscoring the importance of spatial segmentation in urban market analysis.

Manganelli et al. [8] develop a decision support system to promote sustainable urban regeneration as an alternative to land consumption. Using the Analytic Hierarchy Process (AHP), the authors construct an ex ante economic–financial risk index integrating market, planning, and socio-economic variables. Applied to the city of Potenza, the model identifies semi-central areas as the most critical for investment risk, supporting balanced urban development strategies.

Battisti et al. [9] examine the effects of digitalization and remote working on residential mobility, highlighting a shift from central cities to peripheral and rural areas. Housing affordability in the Metropolitan City of Florence is assessed using the Debt-to-Income Ratio (DTI). The results show that nearly 69% of residents are excluded from the central housing market, emphasizing affordability as a key parameter for inclusive housing and planning policies.

Maselli and Nesticò [10] propose an advanced valuation methodology for data-scarce urban real estate markets. Three machine learning algorithms—k-Nearest Neighbors, Random Forest, and Artificial Neural Networks—are tested in the city of Salerno. Explainable AI techniques, including SHAP values, identify key pricing factors, with Random Forest offering the best balance between predictive accuracy and interpretability.

Rosato and Galante [11] use a Multi-Layer Perceptron (MLP) neural network to forecast residential transaction volumes across 99 Italian provinces (2005–2020). The results show that transaction activity is driven mainly by macroeconomic factors—such as employment, income, and interest rates—rather than prices alone. The nonlinear model outperforms traditional econometric approaches in capturing complex territorial dynamics.

Fregonara et al. [12] propose a multidisciplinary framework to support real estate development decisions by comparing new construction and building regeneration. Economic, environmental, and social dimensions are integrated through Net Present Value (NPV) analysis and multicriteria methods such as AHP. Tools including Life Cycle Costing (LCC),

Life Cycle Assessment (LCA), and Social Return on Investment (SROI) are used to quantify long-term impacts, promoting holistic and transparent decision-making.

Yang et al. [13] present a method to improve the evaluation of ESG governance reports by reducing subjectivity through fuzzy systems theory. Semantic–linguistic variables and logical rules replace simple weighted averages to assess qualitative aspects of corporate strategies. Membership functions and defuzzification techniques transform qualitative judgments into nuanced numerical scores, offering a rigorous tool for strategic decision-making and continuous environmental performance improvement.

3. Emerging Paradigms in Real Estate Evaluation: From Qualitative Ambiguity to Fuzzy Precision

Traditional evaluation methods, such as binary Boolean "check-the-box" approaches or simple statistical rankings, are increasingly inadequate for assessing the effectiveness of modern Environmental Management Plans (EMPs). These legacy systems often fail to distinguish between plans that are comprehensive on paper and those that are technologically and operationally feasible in practice, creating a "subjectivity gap" that poses significant risks for institutional investors. Recent research in real estate sustainability and urban regeneration highlights the persistent difficulties in integrating unconventional and qualitative data into benchmarks capable of guiding strategic and operational decisions [8,12]. Moreover, the inability of traditional decision support tools to properly process non-numerical indicators constrains effective strategic planning and obscures the true risk profile of real estate and territorial assets [3–5]. Addressing these limitations requires a fundamental shift in how linguistic variables are processed, moving toward mathematical frameworks capable of handling the inherent uncertainty of expert judgment.

Within this methodological transition, fuzzy theory represents a cornerstone, providing the mathematical apparatus necessary for transforming imprecise human language into quantifiable and actionable data. Fuzzy-based systems enable the translation of qualitative assessments—such as "good," "excellent," or "feasible"—into continuous degrees of membership ranging from 0 to 1, allowing for a structured evaluation of qualitative ESG information. This mathematical infrastructure is increasingly recognized as a prerequisite for institutional-grade ESG audits, strengthening the credibility of sustainability disclosures and mitigating the risk of greenwashing. Recent applications in the construction and real estate sectors demonstrate the effectiveness of intelligent and hybrid evaluation models for enhancing ESG assessment transparency and robustness [1,10]. Beyond simple data aggregation, these models incorporate defuzzification processes that yield "crisp" and comparable scores, which are essential for ESG governance and capital allocation decisions [8].

The determination of weights among sustainability indicators in real estate and construction projects constitutes a high-level strategic exercise that directly influences perceived project risk. Studies on heritage upcycling, sustainable construction, and urban regeneration emphasize the need to assign a greater importance to indicators related to renewable energy, site safety, and territorial impact in order to reflect sectoral priorities accurately [6,11,12]. This prioritization becomes particularly critical in specialized and complex facilities, where the technical configuration of the fuzzy model itself acts as a strategic differentiator. As demonstrated by Yang et al. (2024) [13], the choice of membership functions—Gaussian, Triangular, or Trapezoidal—is not merely an academic preference but a deliberate decision aimed at tightening performance thresholds. Narrowing the range associated with positive qualitative judgments within Triangular or Trapezoidal functions effectively operates as an institutional-level quality control mechanism, ensuring that only genuinely high-performing assets attain top-tier sustainability scores [7,9].

The empirical validation of these models confirms that logic-based scoring is essential to avoid the "inflated average" effect commonly associated with traditional weighted aggregation methods. A conventional weighted average may conceal critical weaknesses—such as limited technological feasibility—by offsetting them with high scores in other dimensions, such as documentation completeness. In contrast, fuzzy logic-based approaches penalize such inconsistencies in a coherent manner, producing a more realistic representation of project risk and performance. This logic proves particularly valuable along the real estate supply chain, where advanced decision support systems facilitate partner and investment selection based on demonstrable ESG maturity, thereby reducing subjective bias and reinforcing investor confidence [1,10].

In an era marked by economic volatility, geopolitical tensions, and the persistent effects of the COVID-19 pandemic, the evaluation of qualitative implementation strategies has become a prerequisite for urban resilience. Assessment methodologies must evolve to incorporate resilient city development processes in which territorial engineering contributes to long-term economic and social stability. Recent studies on environmental risk within territorial transformation processes and on integrated urban indicator systems underscore the importance of evaluating partially non-quantifiable dimensions, such as governance quality and climate policy orientation, in order to capture systemic urban performance [2,5]. Additionally, the integration of temporal variables—specifically, the speed of implementation—emerges as a critical differentiator. Within fuzzy evaluation frameworks, positive implementation schedules can significantly enhance final scores, thereby incentivizing the acceleration of adaptation projects and transforming theoretical resilience strategies into bankable, high-speed infrastructure developments.

The future of real estate valuation in an ESG-driven context ultimately depends on the transition from purely subjective expert opinions toward structured, fuzzy logic-based precision. By integrating civil engineering, territorial economics, and advanced mathematical frameworks, the sector can overcome the limitations of binary assessments and traditional averaging techniques. This transition represents not merely a technical refinement but a necessary evolution to ensure global sustainability and economic stability. As ESG criteria continue to shape financial markets and regulatory frameworks such as the Corporate Sustainability Reporting Directive (CSRD) become standard practice, these advanced evaluation paradigms will provide the clarity, comparability, and credibility required to guide the real estate sector toward a resilient and sustainable future.

4. Future Research Outlines

The field of real estate valuation is evolving beyond the traditional focus on the physical and financial characteristics of assets. To effectively integrate ESG (Environmental, Social, and Governance) performance into valuation practices, the following action-oriented roadmap can be followed.

Develop Tools to Translate ESG Strategies into Operational Metrics

A significant priority is the creation of models capable of converting qualitative sustainability strategies into measurable and actionable indicators. This requires:

- Designing evaluation frameworks that move beyond binary (yes/no) assessments or purely expert-based rankings.
- Defining measurable parameters related to plan completeness, technical feasibility, implementation progress, and strategic coherence.
- Embedding these parameters into conventional valuation methodologies to ensure that ESG considerations directly influence asset appraisal.

Implement Fuzzy Logic Systems for Nuanced Assessment

To overcome the rigidity of traditional evaluation methods, fuzzy logic models should be introduced to capture gradations in ESG performance. Key actions include:

- Optimizing membership functions to accurately reflect varying levels of sustainability performance.
- Refining defuzzification methods to ensure that outputs are transparent, comparable, and decision-ready.
- Developing multi-rule systems capable of modeling interdependencies among Environmental, Social, and Governance factors.
- Incorporating bias reduction mechanisms to enhance objectivity and limit evaluator subjectivity.

Ensure Scalability and Cross-Sector Applicability

For widespread adoption, these models must be adaptable across scales and sectors. Recommended steps include:

- Testing fuzzy-based ESG evaluation systems in urban planning, transport infrastructure, and land-use development projects.
- Integrating the results into governance processes, capital allocation strategies, and risk management frameworks.
- Establishing verification protocols that enhance traceability and reduce greenwashing risks through objective, evidence-based criteria.

Promote Empirical Validation and Longitudinal Monitoring

To position these advanced methodologies as industry standards, empirical validation is essential. This involves:

- Conducting longitudinal case studies on real-world projects.
- Linking fuzzy-based ESG scores with measurable sustainability outcomes, financial performance indicators, and regulatory compliance records.
- Developing shared data repositories to support benchmarking, transparency, and continuous methodological improvement.

By systematically implementing these actions, real estate valuation can transition toward a more transparent, resilient, and sustainability-driven framework—where ESG performance is not merely declared, but rigorously measured, validated, and strategically embedded in investment and planning decisions.

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