

## Literature reviews:

1. Kovacs-Györi, A., Ristea, A., Havas, C., Mehaffy, M., Hochmair, H. H., Resch, B., Juhasz, L., Lehner, A., Ramasubramanian, L., & Blaschke, T. (2020). Opportunities and Challenges of Geospatial Analysis for Promoting Urban Livability in the Era of Big Data and Machine Learning. *ISPRS International Journal of Geo-Information*, 9(752).

In the era of big data and advanced geospatial analysis, urban planning and the pursuit of enhancing urban livability have entered a transformative phase. The integration of Geographic Information Systems (GIS), social media data, and machine learning offers unprecedented opportunities for urban development. However, these advancements are not without significant challenges. This literature review outlines the major challenges as identified in the seminal work "Opportunities and Challenges of Geospatial Analysis for Promoting Urban Livability."

### Challenge 1: Data Volume and Noise

A primary challenge in leveraging big data for urban analysis is managing the sheer volume of data, which is often characterized by its noisy nature. The data's inherent imprecision, ambiguity, and inaccuracy can obscure the dynamics of urban challenges and hinder the path to resolution (Opportunities and Challenges o.pdf). This issue underscores the difficulty in extracting meaningful and actionable insights from vast datasets.

### Challenge 2: Data Integration and Interoperability

Another significant challenge lies in the integration of data from diverse sources. Urban data collected through different methods and for various purposes often lack standardization, making interoperability a major concern. This fragmentation not only complicates the data analysis process but also raises questions about the reliability and comparability of data sets.

### Challenge 3: Ethical and Privacy Concerns

The use of big data, particularly data derived from social media and other personal sources, raises ethical and privacy concerns. The balance between leveraging data for public good and respecting individual privacy rights is a delicate and ongoing debate in the field. Ensuring ethical data use while maintaining public trust is a challenge that urban planners and data scientists must navigate carefully.

### Challenge 4: Technical Expertise and Interdisciplinary Collaboration

The complexity of big data and advanced geospatial analysis requires a high level of technical expertise. There is a need for skilled professionals who can manage, analyze, and interpret large datasets effectively. Moreover, the interdisciplinary nature of urban systems analysis calls for collaboration among urban planners, GIS experts, data scientists, and policymakers, posing a challenge in terms of communication and coordination across diverse fields.

### Conclusion

The utilization of geospatial analysis and big data in urban planning presents a promising avenue for enhancing urban livability. However, the challenges of data volume and noise, data

integration, ethical considerations, and the need for technical expertise and interdisciplinary collaboration highlight the complexities involved in this endeavor. Addressing these challenges is crucial for the effective use of big data in shaping sustainable and livable urban environments.

**2. Lee, J.-G., & Kang, M. (2015). Geospatial Big Data: Challenges and Opportunities. *Big Data Research*, 2(2), 74–81. <https://doi.org/10.1016/j.bdr.2015.01.003>**

In the article "Geospatial Big Data: Challenges and Opportunities," the authors delve into the complexities and potential of geospatial big data. They identify several key challenges, including:

**Volume and Velocity:** The immense size and rapid accumulation of geospatial data pose significant storage and processing challenges.

**Data Variety and Integration:** The wide range of data types and sources necessitates sophisticated integration techniques for cohesive analysis.

**Computing Power and Advanced Algorithms:** The need for robust computing infrastructure and sophisticated algorithms to handle and analyze this diverse and voluminous data efficiently.

These challenges underscore the intricacies of working with geospatial big data, highlighting the need for advanced solutions in data management and analytics. The article also emphasizes the transformative potential of geospatial big data across various sectors, from urban planning to healthcare, driving home its significance in modern technological and societal advancements.

**3. Robinson, A. C., Demšar, U., Moore, A. B., Buckley, A., Jiang, B., Field, K., Kraak, M.-J., Camboim, S. P., & Sluter, C. R. (2017). Geospatial big data and cartography: research challenges and opportunities for making maps that matter. *International Journal of Cartography*, 3(sup1), 32–60. <https://doi.org/10.1080/23729333.2016.1278151>**

The article "Geospatial Big Data and Cartography: Research Challenges and Opportunities for Making Maps that Matter" discusses the new challenges and opportunities presented by geospatial big data for cartographic research. It addresses technical, methodological, and artistic aspects of cartography in the context of big data. The paper outlines key research challenges organized into areas like making sense of geospatial big data, volume, variety, velocity, veracity, and the integration of art.

**Volume of Data:** The challenge lies in effectively managing and analyzing large datasets. This involves creating efficient storage, retrieval, and processing systems that can handle the scale of data without compromising performance.

**Data Variety:** This involves integrating diverse data formats from various sources into a unified, coherent framework. It's crucial to develop methods for harmonizing data that vary in structure, resolution, and temporal frequency.

**Data Velocity:** The rapid generation and updating of geospatial data demand real-time processing and analysis capabilities. Developing systems that can keep pace with this data flow is a significant challenge.

**Data Veracity:** Ensuring the accuracy and reliability of data is critical, especially considering the varied sources and potential biases in geospatial data. Developing robust validation and quality control methods is essential.

**Integration of Art and Aesthetics:** This challenge involves marrying the technical precision of cartography with artistic elements to make maps more engaging and informative. It's about creating visually appealing maps without sacrificing accuracy and functionality.

**Making Sense of Data:** The key challenge is to derive meaningful insights from complex datasets and present them in a user-friendly manner. This involves developing innovative visualization and interpretation techniques that make complex data accessible and understandable.

**4. Koldasbayeva, D., Tregubova, P., Gasanov, M., Zaytsev, A., Petrovskaia, A., & Burnaev, E. (2023). Challenges in data-based geospatial modeling for environmental research and practice. *arXiv.Org*. <https://doi.org/10.48550/arxiv.2311.11057>**

The article "Challenges in Data-Based Geospatial Modeling for environmental research and practice" provides a comprehensive analysis of the complexities encountered in geospatial modeling using machine learning. It identifies and discusses significant challenges such as dealing with imbalanced data, the impact of spatial autocorrelation, and the necessity of uncertainty quantification in model predictions.

**Imbalanced Data:** This involves the uneven distribution of classes in datasets, leading to biased model performance favoring the majority class. Such imbalance is common in environmental data.

**Spatial Autocorrelation:** This refers to the phenomenon where nearby or adjacent data points are more similar than distant ones. This can lead to misleading results in models that assume data points are independent.

**Uncertainty Quantification:** It's essential to estimate and communicate the uncertainty in model predictions. This is crucial for informed decision-making, as it acknowledges the limitations and variability inherent in model outputs.

These challenges are critical for accurate and reliable environmental research and practice. The article also offers insights into various techniques and tools to address these issues, thereby contributing to advancements in the field of geospatial modeling.

**5. Runfola, D., Stefanidis, A., Lv, Z., O'Brien, J., & Baier, H. (2024). A multi-glimpse deep learning architecture to estimate socioeconomic census metrics in the context of extreme scope variance. *International Journal of Geographical Information Science*. <https://doi.org/10.1080/13658816.2024.2305636>**

The study "A multi-glimpse deep learning architecture to estimate socioeconomic census metrics in the context of extreme scope variance" utilizes Convolutional Neural Networks (CNNs) to extract information from satellite imagery, particularly to estimate aggregated information across highly variable geographic extents. The research focuses on a case study involving 2358 Mexican municipalities, which vary significantly in size, to estimate a range of census variables using coarse-resolution Landsat satellite imagery. The authors implement a multi-glimpse recurrent attention model that parametrically determines subsets of each municipality to sample across iterative steps. The model's effectiveness is demonstrated through a five-fold validation, which shows that nearly half of the 52 tested variables can be estimated with  $r^2$  values greater than 0.75. These results indicate the significant potential of using satellite imagery to estimate socioeconomic factors, both in historical periods where surveys were not conducted and in contemporary regions that are otherwise inaccessible.