Behavioural Dynamics and Geospatial Insights: A Framework for Reducing Household GHG Emissions through Tailored Strategies

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Abstract:

Greenhouse gas (GHG) emissions from households constitute a substantial share of the global carbon footprint, driven by everyday activities such as energy consumption, transportation, or waste management. Despite their significance, household emissions are often underrepresented in research on mitigation strategies tailored to specific communities (Capstick et al., 2014; Robertson, 2021). This gap underscores the necessity for targeted approaches that consider the unique characteristics of household behaviours and their interactions with local systems and policies. Addressing these emissions effectively requires a nuanced understanding of both the behaviours driving these activities and the systemic barriers preventing change (Faber et al., 2012). Despite advancements in technology and policy, behavioural obstacles—rooted in socio-economic, cultural, and psychological factors—continue to hinder widespread adoption of sustainable practices (Tiberio et al., 2022). To overcome these challenges, it is essential to identify not only the obstacles to behavioural change but also the resources available to support individuals and communities in transitioning to more sustainable lifestyles.

Based on a systematic and multifaceted methodology this research analyses the behavioural dynamics influencing household greenhouse gas (GHG) emissions. By utilizing an innovative geospatial approach, the study seeks to explore whether targeted behavioural changes, supported by available geospatial resources, infrastructures and services can lead to a reduction in GHG emissions. Integrating behavioural analysis and spatial insights, the research seeks to identify and overcome obstacles while promoting the adoption of sustainable practices through targeted, location-specific strategies.

To achieve this aim, a comprehensive list of GHG-reducing behaviours has been developed by synthesizing findings from sustainability literature and best practices. These behaviours span critical domains such as energy efficiency, sustainable transportation, waste management, and eco-conscious consumption. To examine the spatial distribution of these behaviours, a city-wide questionnaire has been administered ("Baromètre de l'Action Climatique"), targeting residents across all the neighbourhoods of Quebec City. The survey collected detailed data on existing practices and residents' tendencies to adopt more sustainable behaviours, allowing for the identification of spatial patterns in environmental attitudes and actions in Quebec City. More than 100 variables have been collected through a web survey conducted by the Leger[1] firm from October 2 to 14, 2024. 1,505 adult residents of Quebec City have responded to the survey. The results have been weighted by municipal district of residence, age, gender, region, education level, and number of children in the household. This information is crucial for pinpointing which neighbourhoods exhibit higher readiness for behavioural change and where additional support may be needed to foster more sustainable practices.

Building on the spatial patterns identified through the survey, the subsequent analysis aims to explore the barriers and resources required to facilitate these transitions. To achieve this, a thorough review of academic and policy literature is undertaken, identifying prevalent obstacles that impede behavioural change. These obstacles, including cultural and economic barriers, infrastructural deficits, and informational gaps, are analysed to provide geospatially explicit insights into the resources required for change. Subsequently, a catalogue of geospatial resources tailored to each neighbourhood in Quebec City is developed. This catalogue includes mapping of existing infrastructure, such as public transportation networks, recycling facilities, and energy-efficient housing programs, which can support the adoption of sustainable

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[1] https://leger360.com/

practices. Furthermore, it also highlights gaps in infrastructure and services that need to be addressed to facilitate behavioural changes. These insights provide a foundation for designing targeted, neighbourhood-specific interventions, ensuring resources are directed where they are most needed.

To further refine this approach, a suite of geospatially enabled indicators will be developed. These indicators synthesize data on resource availability, obstacles, and the unique spatial characteristics of each neighbourhood, quantifying the residents' likelihood of adopting specific GHG-reducing behaviours. Advanced geospatial modelling techniques will be employed to calibrate these indicators, ensuring they accurately represent the complex interplay of geospatial factors affecting behavioural change. Designed for multi-scale application, these indicators can be utilized at neighbourhood, municipal, or regional levels, allowing for tailored interventions that address specific needs and conditions at each scale. By integrating multiple data sources, these indicators will provide a comprehensive view of the challenges and opportunities within each area. The culmination of these analyses is an evidence-based tool that policymakers and planners can rely on to prioritize actions and maximize the effectiveness of sustainability initiatives.

The innovative integration of behavioural data from questionnaires and resources through geospatial analysis offers a robust decision-support framework for policymakers, urban planners, and municipalities. This framework facilitates the development of tailored, neighbourhood-specific interventions, optimizing resource allocation and enhancing community-wide efforts to mitigate GHG emissions. Its predictive capabilities empower decision-makers to anticipate the outcomes of proposed policies and prioritize investments for maximum effectiveness. By embedding behavioural insights into spatial analytics, this research provides actionable, locally relevant strategies that support municipalities in fostering equitable and impactful solutions for sustainable urban development. Furthermore, it highlights the interconnectedness of behavioural trends and urban infrastructure, showcasing how small-scale interventions can cascade into larger systemic impacts. By encouraging collaboration between stakeholders, such as government agencies, community organizations, and private entities, this framework promotes inclusive decision-making. Ultimately, it supports the dual goals of environmental sustainability and social equity, making urban spaces more resilient and adaptable to evolving challenges.

Acknowledgements

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