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Exploring Network Analysis for Urban Planning and Disaster Risk Reduction in Informal Settlements:
Cases From Honduras, Jamaica, and Peru

Vicente Sandoval, Florida International University, USA
https://orcid.org/0000-0001-8044-1567

Juan Pablo Sarmiento, Florida International University, USA
https://orcid.org/0000-0001-8192-902X

Erick Alberto Mazariegos, Oficiocolectivo, Costa Rica
https://orcid.org/0000-0001-8992-1698

Daniel Oviedo, University College London, UK

ABSTRACT

The work explores the use of street network analysis on informal settlements and discusses the potential and limitations of this methodology to advance disaster risk reduction and urban resilience. The urban network analysis tool is used to conduct graph analysis measures on street networks in three informal settlements in the LAC region: Portmore, Jamaica; Tegucigalpa, Honduras; and Lima, Peru. Authors incorporate risk variables identified by these communities and combine them with prospective scenarios in which street networks are strategically intervened to improve performance. Authors also compute one graph index named Reach centrality. Results are presented spatially through thematic maps, and statistically by plotting cumulative distributions. Findings show that centrality measures of settlements' networks helped identify key nodes or roads that may be critical for people's daily life after disasters, and strategic to improve accessibility. The proposed methodology shows potential to inform decisions on urban planning and disaster risk reduction.

KEYWORDS

Cities, Disaster Risk Management, Disasters, Informality, Latin America and the Caribbean, Neighborhood Scale, Urban Development, Urban Informality, Urban Network Analysis

INTRODUCTION

Street Network Analysis for Informal Settlements

With half of the world's population living in cities nowadays, and another two billion people expected to move into urban areas in the next two decades, the pressures of rapid and uncontrolled urbanization can mean that careful urban planning is more difficult today than ever. The United Nations Human Settlements Programme (UN-Habitat) estimates that China will need to build new cities for 350 million people in the next 20 years, and over the same period, 250 million new urban dwellers are

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expected in India and 380 million in Africa (UN-Habitat, 2016). Compliance with urban regulations and zoning are being omitted in complex processes such as those presented by informal settlements, where about 880 million people currently live: 106 million in the Latin America and the Caribbean (LAC) region (UN-Habitat, 2016). It is considered that 70 percent of today's urban growth occurs without the benefit of formal planning processes, and maybe for that reason informal settlements are considered the most common form of urbanization on the planet (Davis, 2006). This also implies that if these trends do not change, the inefficiencies of contemporary cities may become the norm in the future (Daniels, 2011). Such scenario can be hindered also by an accelerated disaster risk creation (DRC) —faster than disaster risk reduction (DRR)—, as root causes and drivers of informal settlements and vulnerability often leave people with no other choice but to occupy hazard-exposed areas (sometimes the only available for the poor) while devoid of basic urban services (Lewis & Kelman, 2012).

Researchers of the City Form Research Group at the MIT School of Architecture & Planning (SA+P) have recently created a new set of simulation tools that offers urban analysts and city planners a better understanding of how the spatial patterns of cities affect people's mobility and accessibility. Improving people's mobility within cities and making city's potentials accessible to all is critical for an equal access to opportunities and urban justice (UN-Habitat, 2003, 2016), as well as for making cities safer and resilient. By using mathematical network analysis methods from graph theories, the Urban Network Analysis (UNA) tool examines urban networks centrality and redundancy, while it offers to policymakers a detailed look at how their decisions would shape different aspects of urban development, such as where traffic is likely to be highest and on which streets local commerce is most likely to flourish (Daniels, 2011). In this sense, this paper aims to explore the gap between formal and informal urbanization processes through the above-mentioned simulation tool, while supporting local governments, and development and community organizations' planning decisions.

This paper bases on the evaluation of the Urban DRR programming carried out in Latin America and the Caribbean by Sarmiento et al. (2018), supported by the United States Agency for International Development's Office of U.S. Foreign Disaster Assistance (USAID/OFDA). The evaluation conducted between 2017 and 2018 focused on the assessment of eight projects funded by USAID which applied the Neighborhood Approach for DRR (NA-DRR) which seek to find practical and workable solutions for DRR in densely populated informal urban settlements in Colombia, Guatemala, Haiti, Honduras, Jamaica, and Peru. Based on the data availability for this study, authors have selected three settlements to analyze each street network and urban accessibility using the UNA tool: José Arturo (J.A.) Duarte in Tegucigalpa, Honduras, Leticia in Lima, Peru, and Naggo Head in Portmore, Jamaica. Particularly, authors conducted a graph centrality measure named Reach centrality. Moreover, to study urban networks and how these can be affected under certain risk scenarios, authors incorporate disaster risk variables identified by these communities such as floods and landslides areas. Likewise, authors also combine such analyses with prospective scenarios in which urban networks are strategically intervened to improve neighbors' mobility.

The purpose of this work is, on the one hand, to offer reflections on the potential use of the UNA tool in characterizing informal settlements, specifically on how do graph centrality measures (i.e., Reach) perform within delimited informal neighborhoods, and on the other hand, to explore how these results can be useful to inform decisions on urban planning and disaster risk reduction in informal and precarious settlements.

Confronting how rigid formal planning processes and state apparatus tend to produce informality is the first step to deal with informal urbanization (Roy, 2005). This also implies to leave behind the idea that informal settlements are unplannable and the opposite to formal, as these were a seemingly natural phenomenon that is external to those studying it and managing it (Mitchell, 2002). Yet, studying the spatial configuration of cities and their associated social, economic, and environmental processes has been generally identified with the analysis of 'formal' urban contexts (Boeing, 2018). Moreover, urban network analyses tend focus on metropolitan and city scales as small sample sizes

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