

Building Climate Resilience in Urban Informal Settlements through Data Co-production



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Climate change is worsening the number, frequency and duration of natural hazards across the globe, making disaster risk reduction and resilience building among the most pressing challenges ahead.

According to UN-Habitat, informal settlements are where the impacts of climate change are the most acute in urban areas and strengthening resilience in these neighbourhoods represents a very complex yet urgent challenge.¹ Today, urban areas are

home to 56 per cent of the world's population and this figure is projected to increase to 60 per cent by 2030 and 68 per cent by 2050, with 90 per cent of the growth by 2050 expected to occur in less developed economies.² In these countries, population growth and displacement (including climate-driven migrations) will lead to rapid and unplanned urbanisation forcing a

¹ David Dodman, Diane Archer and Marcus Mayr, *Pro-poor Climate Action in Informal*

Settlements, Nairobi, UN-Habitat, November 2018, <https://unhabitat.org/node/128323>.

² Neil Khor et al., *World Cities Report 2022. Envisaging the Future of Cities*, Nairobi, UN-Habitat, 2022, p. 9, <https://unhabitat.org/node/161573>.

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growing number of people into informal settlements. Currently, one billion people live in informal settlements, mostly in Asia, Sub-Saharan Africa and Latin America and this figure is expected to grow to 3 billion in 2050.³

Context-specific challenges in informal settlements

Informal settlements are built within or around the 'formal' city but outside of the official system of laws and regulations aimed at ensuring safe settlements. Climate change is rapidly posing additional risks to these communities, making them among the most vulnerable to natural hazards. Their increased vulnerability is caused mainly by three underlying factors. Firstly, they are typically situated in environmentally fragile areas such as riverbanks, steep hillside slopes, low-lying land and coastal shores, relying on precarious infrastructures and housing. Secondly, socioeconomic conditions such as illiteracy and poverty prevent these communities from accessing adequate information about climate change risks and dealing with them. Thirdly, the political and institutional marginalisation of these neighbourhoods often leads to the absence of risk-reducing measures. Building resilience in informal settlements requires a nuanced and in-depth understanding of their specific physical and social conditions, as well as differentiated vulnerabilities, in order to plan strategies that are feasible and targeted.

³ UN-Habitat website: *Participatory Slum Upgrading Programme Fund*, <https://unhabitat.org/node/120239>.

In light of these context-specific vulnerabilities, resilience policies are increasingly shifting their focus towards "smaller spatial scales" with growing attention to localised resilience practices. From this perspective, building resilience of the individual, the neighbourhood and the community is the most effective pathway to resilience of the whole system.⁴

These approaches have emerged as a response to conventional disaster risk management models that are primarily based on decontextualised and exogenous paradigms of risk and development. Such traditional approaches proved to be problematic, especially when applied to resilience building in marginalised communities, such as informal urban settlements. By using parameters and data that are not tailored to the particular reality of poor and informal neighbourhoods, conventional approaches fail to capture highly localised – yet critical – aspects of these communities. In particular, they overlook the social aspects of vulnerability and important factors related to local physical infrastructures. For instance, in informal settlements, the lack of storm drainage combined with the lack of waste management systems can lead not only to flooding, but to flood water being contaminated, causing health impacts. Moreover, many informal settlements are very dense, with little open space and narrow

⁴ Jon Coaffee, João Porto de Albuquerque and Vangelis Pitidis, "Risk and Resilience Management in Co-production", in Elke Loeffler and Tony Bovaird (eds), *The Palgrave Handbook of Co-production of Public Services and Outcomes*, Cham, Palgrave Macmillan, 2021, p. 541-558 at p. 542.

access roads that can limit interventions by emergency services making natural hazards more damaging and deadly. At the same time, inhabitants might resist evacuations as they have limited guarantees that they can return to their homes after the recovery efforts.

Localised resilience approaches: From consultation to co-production

Localised resilience approaches aim at adjusting conventional methodologies to account for the “differential socio-spatially determined vulnerability to natural hazards” with the objective of improving risk governance and achieving better resilience outcomes.⁵ These approaches have at their core the engagement of a significantly wider group of stakeholders in the decision-making process, including individuals, professionals, community groups and local institutions – as opposed to traditional risk management approaches that usually rely on a narrow group of governmental stakeholders. The aim is to build the ability of the community to withstand external shocks by engaging at a deeper level with its social fabric, grasping the specific social and physical characteristics, the differential needs and capabilities of that context.

Since the publication of the first Intergovernmental Panel on Climate Change (IPCC) report in the 1990s,⁶ community participation in climate

adaptation and resilience decision-making has been recognised as an effective way to ensure legitimacy and local compliance with relevant policies and measures. At the time, the practice of “consultation” was the main tool used to achieve representation of the different interests in the design of resilience strategies, including those of marginalised communities. Nevertheless, over time, researchers and policymakers understood the limitations of the consultation mechanism. There is, in fact, “a critical difference between going through the empty ritual of participation and having the real power needed to affect the outcome of the process”.⁷

In response to the limitations of the consultation mechanism, in recent years, the “co-production” approach has gained ground as a participatory process better suited for supporting community engagement in climate resilience planning. This approach requires overcoming the rigid boundary between scientists and citizens, where knowledge is simply transferred to communities. In co-production, a partnership is established between traditional decision makers (such as the government or scientists) and communities that become co-producers of knowledge about climate risks and resilience. Thus, in contrast

⁵ Ibid., p. 543.

⁶ Intergovernmental Panel on Climate Change (IPCC), *Climate Change: The IPCC Response Strategies*, World Meteorological Organization and UNEP, 1990, <https://www.ipcc.ch/report/ar1/wg3>.

⁷ Isabel Ruiz-Mallén, “Co-production and Resilient Cities to Climate Change”, in Janez Nared and David Bole (eds), *Participatory Research and Planning in Practice*, Cham, Springer, 2020, p. 1-11 at p. 2, <https://doi.org/10.1007/978-3-030-28014-7>; Sherry R. Arnstein, “Ladder of Citizen Participation”, in *Journal of the American Institute of Planners*, Vol. 35, No. 4 (1969), p. 216-224 at p. 216, DOI 10.1080/0194436690897722.

to more traditional participatory processes, through co-production citizens are not merely consulted but actively shape decisions through their values, needs, perspectives and priorities in order to improve their reality.⁸

The co-production approach stems from the recognition of the crucial role that local knowledge has in developing innovative and successful resilience strategies, especially with regard to preventing maladaptation practices.⁹ As research has shown, communities hold crucial knowledge about risks and vulnerability to natural disasters and they know what coping responses and adaptive strategies might or might not work in their specific context.¹⁰ Communities for instance develop “experiential knowledge”, that is knowledge based on previous experiences of natural disasters. This can include information about “what to stock for emergencies, how to keep essential supplies secure, where to turn to get quick help from within the community”, as well as

⁸ Isabel Ruiz-Mallén, “Co-production and Resilient Cities to Climate Change”, cit., p. 3; Raul P. Lejano, C. Emdad Haque and Fikret Berkes, “Co-production of Risk Knowledge and Improvement of Risk Communication: A Three-Legged Stool”, in *International Journal of Disaster Risk Reduction*, Vol. 64 (October 2021), Article 102508, <https://doi.org/10.1016/j.ijdrr.2021.102508>.

⁹ Isabel Ruiz-Mallén, “Co-production and Resilient Cities to Climate Change”, cit., p. 3. Maladaptation practices are adaptation measures taken to cope with stresses and shocks that lead to a reduced ability to deal with future challenges associated with climate change, increasing the community’s vulnerability.

¹⁰ Raul P. Lejano, C. Emdad Haque and Fikret Berkes, “Co-production of Risk Knowledge and Improvement of Risk Communication”, cit.

information about the most vulnerable infrastructures and most dangerous areas.¹¹ For instance, research carried out in Bangladesh highlights that only by tapping into community knowledge, researchers understood that having separate facilities for women and provisions for children in cyclone shelters was essential in order to achieve a consistent use of these life-saving infrastructure by the population.¹² Furthermore, recent studies have argued that widespread “paternalistic attitudes” from decision makers and failure to engage in participatory processes during the design of climate resilience measures can lead to “exacerbating the social pre-conditions of the disaster”,¹³ leading marginalised communities to suffer greater damages to assets, disruption of socio-economic activities and human losses compared to other areas.

Participatory processes and transformative social change

Localised resilience approaches, designed through participatory processes and in particular through co-production, when applied to marginalised and disempowered communities, have the potential to reduce the vicious circle of inequality. By addressing the differential vulnerabilities and needs of fragile communities against natural disasters, they can prevent climate change impacts from further widening social inequalities. Furthermore, including these communities in participatory

¹¹ Ibid.

¹² Ibid.

¹³ Ibid.

processes to build resilience can initiate a broader transformative social change and hardwire more equitable processes into future decision-making.¹⁴

Many studies show that the active engagement of communities in urban planning to face climate challenges is likely to build not only more resilient, but also more democratic and inclusive cities.¹⁵ The link between resilience building and equality at the urban level is also recognised by UN-Habitat that urges to adopt urban resilience practices that can in parallel underpin more equitable urban development.¹⁶

Data inequalities

Intra-urban social inequalities are also reflected in data inequalities. In poor and informal settlements, data about natural hazards and their impacts are often lacking, representing a key underlying cause for their increased vulnerability. These data gaps indeed prevent the correct assessment of risks, vulnerabilities and resilience capacity. The limited available data are usually generated by digital sensors and fed into centralised systems used for decision-making by scientists and governments, in a traditional top-down approach. However, these conventional data practices “are reliant on long-held

quantitative modelling tools and provide broad and scalable baseline measures that [...] are currently developed at a level of abstraction that does not fully account for local context”.¹⁷ Therefore, relying on top-down and non-context-specific data flows fails to account for the differentiated vulnerabilities of informal settlements, increasing their exposure to risks.

The lack of data on informal settlements is caused by a number of different factors. Due to their status as illegal housing, most governments do not collect data on these settlements, nor do they include them in city assessments and planning. In addition, especially in the Global South, national censuses are not always carried out on a regular basis and local governments rarely have access to them. Even when available, household censuses usually do not include a definition and a dedicated field for informal settlements, while also having sample sizes that are too small to provide data on each urban area including informal neighbourhoods.¹⁸ Moreover, relevant data are often held by different organisations such as universities, research centres, private sector bodies, different government offices and they are not shared to create a consistent and complete database on climate-related risks in marginalised urban areas.

¹⁴ Jon Coaffee, João Porto de Albuquerque and Vangelis Pitidis, “Risk and Resilience Management in Co-production”, cit., p. 543.

¹⁵ Isabel Ruiz-Mallén, “Co-production and Resilient Cities to Climate Change”, cit., p. 1-2.

¹⁶ UN-Habitat, *Seventh Session of the World Urban Forum: Urban Equity in Development - Cities for Life. WUF7 Report*, March 2015, p. 54-55, https://wuf.unhabitat.org/sites/default/files/2022-06/files/WUF7_Report%20medellin%20Colombia%202014.pdf.

¹⁷ Jon Coaffee, João Porto de Albuquerque and Vangelis Pitidis, “Risk and Resilience Management in Co-production”, cit., p. 545.

¹⁸ David Satterthwaite et al., “Building Resilience to Climate Change in Informal Settlements”, in *One Earth*, Vol. 2, No. 2 (21 February 2020), p. 143-156, <https://doi.org/10.1016/j.oneear.2020.02.002>.

The Waterproofing Data project

In order to build resilience in informal settlements, co-production practices aimed at generating context-specific data can be critical both to fill existing data gaps and to actively engage the community. The project “Waterproofing Data: Engaging Stakeholders in Sustainable Flood Risk Governance for Urban Resilience” (WPD) represents a very interesting case study in this respect.¹⁹

The project, led by an international team of researchers from Brazil, the UK and Germany, developed an innovative methodological approach to build resilience to flooding in marginalised urban neighbourhoods through data co-production. WPD aimed at transforming how flood-related data is produced and shared, engaging citizens directly in the process of data generation and creating new governance arrangements between communities, governments and flood experts.

The methodology included three components. The first entailed making the existing flows of flood-related data visible, the second consisted in generating new types of data at the local level by engaging citizens and the third involved integrating citizen-generated data with other data. Therefore, the methodology allowed to combine top-down data (big data generated by centres of expertise) with bottom-up data, which provided essential

information about the physical and social characteristics of the community.

The project was first implemented in two impoverished neighbourhoods of São Paulo and Rio Branco in Brazil and later expanded to another nine Brazilian cities between 2018 and 2022. Researchers engaged with the communities in several data-generation practices, including collecting flood memories and oral history from the elderly, building participatory mapping of risk perceptions and involving school students in citizen science initiatives such as measuring local rainfalls. Through a collaborative design process, the project also developed the mobile app “Dados à Prova D’Água”, where citizens can record data about rainfall and local flood impacts, send warning messages and have access to official data sources.

The results of WPD show that community-generated data on extreme weather events in vulnerable neighbourhoods can successfully address the issue of data inequalities and inform disaster risk monitoring agencies in order to improve risk models. Yet, the positive outcomes of data-generation practices went far beyond increasing data availability. In the involved communities, awareness about climate change and perception of risks associated with floods significantly improved, as well as digital literacy. Moreover, preliminary evidence shows that data-generation activities also had an impact in reducing deaths and damages in the event of severe flooding. In May 2022, a deadly flooding hit the city of Jabotão dos Guararapes; however, in a neighbourhood that

¹⁹ University of Glasgow-Urban Big Data Centre website: *Waterproofing Data*, <https://www.ubdc.ac.uk/research/research-projects/urban-sustainability-participation/waterproofing-data>.



participated in the project in 2021, there were significant damages but no victims. The community had been consistently collecting rainfall data through the mobile app which allowed them to understand the magnitude of the flooding event, send an alert via the app and promptly leave their homes, while in other communities in the same district people did not fully understand the risks and delayed evacuation leading to human losses.

While WPD was implemented in Brazil, its innovative methodology based on data co-production has a strong potential to be applied to other regions of the world and other types of natural hazards, including to urban areas in the Global North that present increased physical or social vulnerabilities to ever more frequent climate extremes.

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