ARPHA Proceedings

Proceedings ECSA-ÖCSK-2024, 0025-0029
doi: 10.3897/ap.e126417

Change – The transformative power of citizen science

Changing for the better: starting to explore citizen science and the development of community resilience

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Abstract

This paper explores the transformative potential of citizen science (CS) in building community resilience during natural and technological disasters. Citizen science involves the engagement of non-professional scientists in scientific endeavors, providing invaluable contributions in data collection, enhancing community awareness, and building local capacities. The cooperative relationships fostered between citizens, academics, and governments are critical for creating informed, localized policies that resonate with community needs and foster resilience. This paper elaborates on the theoretical underpinnings, methodologies, and empirical findings of an initial study, offering first insights into how CS can be systematically integrated into resilience strategies.

Keywords: community resilience, citizen science, participatory methods, hazard protection, public policies, data collection, social capital.

Published by NHM, BOKU and ECSA and peer-reviewed under responsibility of ECSA-ÖCSK-2024 (Change – The transformative power of citizen science)

Introduction

The global rise in natural and technological disasters, exacerbated by climate change and urbanization, underscores the urgent need for effective disaster risk reduction and resilience-building strategies. As a result,

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there is the urgency to make disaster risk reduction and the promotion of resilience a core element in public policy, especially in the case of developing countries (Data Pop Alliance 2015). Resilience emerges both from top-down strategies at the state level and from bottom-up approaches at the local community level, which allow communities to plan and prepare for, absorb, and recover from disasters, adapting to new and diverse conditions (National Research Council 2012).

Community resilience refers to the ability of social entities to withstand, adapt to, and recover from adverse situations. It is increasingly recognized that resilience involves not just recovery, but also the capacity to learn from past disasters and adapt to future challenges (Folke 2006). Citizen science has emerged as a significant participatory approach that involves communities in scientific research, enhancing local knowledge and fostering collaborative problem-solving (Jordan et al. 2015). This paper critically examines the role of citizen science in augmenting community resilience, providing new perspectives on its potential for widespread application.

Methods

This study adopts a broad conceptualization of resilience, viewed as a dynamic process encompassing planning/preparation, absorption, recovery, and adaptation in response to disasters. Citizen science is integrated as a pivotal tool for empowerment and engagement across these stages, with varying levels of citizen involvement from passive data collection to active research design and decision-making (Haklay 2013).

A systematic literature review was employed, utilizing major databases such as Scopus and Web of Science, to explore the nexus between citizen science and community resilience. It is important to note

Table 1. Inclusion criteria used for article selection.

Inclusion criteria	**Scopus**	**Web of Science**
Keywords	Resilient/Resilience Citizen Science Crowd Science	Resilient/Resilience Citizen Science Crowd Science
Subject Area	Social Sciences Business, Management and Accounting Economics, Econometrics and Finance	Social Sciences Interdisciplinary Economics Management
Document Type	Article Review	Article Review Article
Language	English Portuguese	English Portuguese
Scopus Full Query Search		
TITLE-ABS-KEY ((resilien* AND ("citizen science" OR "crowd science"))) AND (LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "ECON")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Portuguese"))		

the limitations associated with the methodology employed: the keyword search was restricted to a limited set of terms, which may not have captured all relevant studies, particularly those that use fewer common terminologies or synonyms not included in our initial list. Furthermore, by limiting our search to Scopus and the Web of Science, we excluded grey literature and other scientific outlets that might be extensively utilized by the citizen science community. The search was conducted following the PRISMA framework (Moher et al. 2015), aiming to encompass a broad array of studies without temporal restrictions. To identify relevant articles, keywords such as resilience, resilient, citizen science, crowd science were used. Table 1 details inclusion criteria used in the search. This approach enabled a detailed exploration of the roles and impacts of citizen science in resilience initiatives globally.

The keyword search retrieved 377 articles from the selected electronic databases, and applying the selected inclusion criteria the number was reduced to 35 articles. Following the removal of 2 duplicates, 33 articles were preliminarily assessed based on their abstracts and keywords. Subsequent evaluation led to the exclusion of irrelevant studies, narrowing the pool to 22 articles. Of these, one article was inaccessible, and 9 were later excluded for lacking clear information on the CS impact, resulting in 12 articles suitable for detailed analysis.

Results and Discussion

The analyzed articles showcase citizen science (CS) initiatives across various global locations, including Nepal, Puerto Rico, Brazil, Italy, the USA, and Australia. These initiatives focus on addressing natural environmental hazards such as floods, extreme heat, and volcanic activities. The level of citizen involvement in these CS projects ranges from basic crowdsourcing to more engaged participatory science approaches. The most common forms of participation noted were distributed intelligence, where citizens engage in simple data gathering and interpretation tasks, and participatory science, which involves citizens more deeply in defining problems, collecting data, and analyzing it with expert support.

The analysis did not uncover instances of extreme citizen science, hinting at a possible need for enhanced educational and training programs to enable more effective citizen involvement in complex data analysis and interpretation. This identifies a critical need for enhancing educational and training programs to enable effective citizen involvement in more sophisticated aspects of CS projects.

Also, the systematic review illuminated several key roles of citizen science across different phases of disaster management:

- **Planning and Preparation:** CS initiatives are crucial for collecting data in remote or understudied areas, thereby aiding in the development of early warning systems and localized preparedness strategies (Pandeya et al. 2021). This proactive involvement allows for better tailored emergency response strategies that are contextually relevant and scientifically robust.
- **Absorption:** During disasters, citizen science contributes to the collection of real-time data, which is vital for understanding community responses and adapting ongoing strategies to manage the crisis effectively (Zhao et al. 2021).

- **Recovery:** Post-disaster, CS helps assess the effectiveness of recovery efforts and gather community feedback, which is instrumental in refining resilience strategies (Stone et al. 2014).
- **Adaptation:** Citizen science also facilitates the involvement of community members in designing and implementing long-term adaptation strategies. This engagement empowers communities, enhancing their preparedness for future challenges and ensuring sustainable resilience practices (Hoffman 2020).

The main conclusions derived from the systematic review corroborate the significant impact of citizen science (CS) on disaster management across various stages, further underscoring the need for integrating these initiatives into broader resilience frameworks (Kliewer and Priest 2019; Sittenfeld et al. 2022). Enhanced engagement through citizen science not only garners local knowledge and community-generated data but also amplifies the policy relevance of such information, ensuring that resilience strategies are not only scientifically robust but also contextually relevant and supported by those they aim to protect.

Conclusion

Citizen science offers a valuable approach for enhancing community resilience by promoting a culture of preparedness and informed response. This paper emphasizes the need for integrating citizen science into broader resilience frameworks to ensure that community-led initiatives are effectively supported and leveraged.

This initial study identifies several practical implications for policymakers and disaster management practitioners. The implementation of citizen science approaches can lead to more informed, community-centered policymaking, thereby enhancing the effectiveness and acceptance of resilience strategies. Additionally, the development of citizen science projects can serve as a catalyst for building local capacities and fostering a culture of preparedness and innovation (Gray et al. 2017). Finally, future research could explore a deeper literature review or apply complementary methods, such as qualitative interviews or participatory action research, to further increase our understanding of citizen science practices and how they contribute to community resilience.

Acknowledgements

This work was supported by the Research Unit on Governance, Competitiveness and Public Policies (UIDB/04058/2020) + (UIDP/04058/2020), funded by national funds through the Foundation for Science and Technology, I.P; as well as, by the Portuguese Foundation for Science and Technology (FCT) through the Scientific Employment Stimulus – Institutional Call – reference CEECINST/00026/2018.

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