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EDITORIAL CONTENT

Policy Perspectives on Citizen Science and Crowdsourcing

Lea A. Shanley*, Alison Parker†, Sven Schade‡ and Aletta Bonn§,‖

The articles in this issue frame challenges and opportunities for citizen science, crowdsourcing, and policy development, and provide relevant case studies in local, regional, national, and international contexts. Topics span from local invasive species management to global sustainable development, and provide both frameworks and recommendations for further consideration.

Keywords: Citizen Science; Crowdsourcing; Policy; Open Science; Government

Citizen science encompasses a range of methodologies that support meaningful contributions of the public to the advancement of scientific and engineering research and monitoring, in ways that may include identifying research questions; conducting scientific investigations; collecting, processing, and analyzing data; developing scientific hardware and software; and solving complex problems. As an emerging field, citizen science has been described in a variety of ways (e.g., Auerbach et al. 2019; Eitzel et al. 2017; Hecker et al. 2019; Heigl et al. 2019; Shanley, Hulbert, and Auerbach 2019). Similarly, crowdsourcing is a methodology that engages a large group of people through an open call to tackle a common task or problem, either as individuals or collectively (Howe and Robinson 2005; Howe 2006). This may include asking the public to submit new ideas, designs, algorithms, or data via an online platform or mobile app, which is sometimes incentivized through a prize or challenge.

The defining characteristic of both citizen science and crowdsourcing, however, is their "location at the point where public participation and knowledge production – or societal context and epistemology – meet, even if that intersection can take many different forms" (Irwin 2015). Irwin argues that these approaches provide an opportunity to bring members of the public and science closer together, to consider the possibilities for a more active "scientific citizenship," [and] "to link these issues into public policy." As several recent studies have demonstrated, citizen science and crowdsourcing can help to provide the evidence-base to inform a wide range of management and public policy decisions while fostering civic partnerships with government (e.g., Bastian and Byrne 2012; Bowser and Shanley 2013; Hecker et al. 2018; Hyder et al. 2015; McKinley et al. 2015; McKinley et al. 2017; Owen and Parker 2018; Pieper et al. 2018; Schade et al. 2017; Fritz et al. 2019).

More than two decades after the publication of Irwin's seminal book on citizen science (Irwin 1995), we see an increasing awareness and use of citizen science by national governments and multilateral organizations to address both scientific and societal challenges (e.g., Haklay 2015; Nascimento et al. 2017). Governments in the United States and Europe, for example, have incorporated citizen science and crowdsourcing as part of their Open Science, Open Innovation, Open Government, and/or Open Data initiatives (e.g., OSTP 2013, 2015; OECD 2016; EC 2016). The United Nations Office for the Coordination of Humanitarian Affairs and the United Nations Platform for Space-based Information for Disaster Management and Emergency Response have used crowdsourcing and citizen science for disaster response and humanitarian relief for nearly a decade (e.g., Shanley et al. 2013), while the United Nations Environment Program is beginning to explore the use of citizen science for addressing the UN Sustainable Development Goals (e.g., Chandler et al. 2017; Fritz et al. 2019). This growing support for citizen science and crowdsourcing by government decision-makers and policymakers is a direct result of the focused grassroots efforts of government agency staff, in partnership with professional citizen science associations and organizations such as SciStarter, as well as the strategic positioning of citizen science and crowdsourcing as methods for addressing agency missions and national priorities (e.g., Bowser et al. In preparation; Göbel et al. 2019; Roger et al. 2019; Shanley et al. In preparation). Through our contributions to these initiatives, the editorial team was inspired to propose this *Special Issue on Policy Perspectives for Citizen Science.*

Conversely, the use and impact of citizen science and crowdsourcing may be constrained by institutional, legal, policy, and regulatory barriers (e.g., Gellman 2015;

* Nelson Institute, University of Wisconsin-Madison, US
† The Wilson Center, US
‡ European Commission, Joint Research Centre, IT
§ Helmholtz-Centre for Environmental Research – UFZ, Friedrich Schiller University Jena, DE
‖ German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, DE
Corresponding author: Lea A. Shanley (lshanley@wisc.edu)

Guerrini et al. 2018). In a survey of four US federal agencies, for instance, we found that data quality and privacy are frequently mentioned as perceived risks to incorporating citizen science into government-led scientific research, management, or policymaking (e.g., Gedney and Shanley 2014). Addressing these challenges may require new policies and legislation as well as new funding programs (e.g., Nascimento et al. 2017; Shanley et al. In preparation).

In addition, a study by the University of the West of England, Bristol, found the potential value of citizen science for informing policy-making "remains largely untapped" (SCU 2013). In our preparation of New Visions for Citizen Science (Bowser and Shanley 2013), we also found that government-sponsored citizen science projects in the US often had a difficult time articulating their public policy impacts. More recently, the European Commission observed that the evidence-base demonstrating the use and effectiveness of citizen science for environmental policy still needs to be developed. A survey of 503 citizen science projects revealed a high variety of intended and realized contributions to policy (EC 2018). To address the remaining gap, the Global Citizen Science Partnership, citizen science associations in Australia, Europe, and the United States, and citizen science practitioners at national and regional levels are developing mechanisms to create a bridge between the citizen science and policy communities.

To foster an enhanced citizen science and public policy interface and to understand the current- and potential-role of citizen science at all levels of government and in governance more broadly, the articles in this Special Issue frame challenges and opportunities for citizen science, crowdsourcing, and policy development, and provide relevant case studies in local, regional, national, and international contexts. Topics range from local invasive species management to global sustainable development and provide both frameworks and recommendations for further consideration. Papers address the following questions:

- What are the opportunities and challenges for citizen science and crowdsourcing to work with decision-makers in local, state, national, regional, and international governments, along with non-governmental organizations, to inform management and to shape or implement public policy? How do we measure success and impact?
- How can we make citizen science and crowdsourcing data and information more trustworthy, efficient, and "actionable" for management and public decision-making?
- What legal, policy, regulatory, and institutional issues must be addressed when developing and implementing citizen science and crowdsourcing projects? What strategies may improve bureaucratic processes to increase the impact of citizen science on public sector policies and practices?
- How can science and technology policy support citizen science and crowdsourcing, either through opening opportunities or mitigating barriers?

Framing

In the article *How Does Citizen Science "Do" Governance? Reflections from the DITOs Project*, Claudia Göbel, Christian Nold, Aleksandra Berditchevskaia, and Mordechai Haklay discuss how citizen science relates to and draws on governance processes and thereby frames the discussion on citizen science impact even more broadly than government and policy. The authors illustrate their research with examples from the "Doing It Together Science" (DITOs) project paired with concepts from Science and Technology Studies as well as political and social sciences. Equally cross-cutting, Susanne Hecker, Nina Wicke, Mordechai Haklay, and Aletta Bonn analyze the use of the term "citizen science" in international policy documents in their article *How Does Policy Conceptualise Citizen Science? A qualitative Content Analysis of International Policy Documents*. This work provides a greater understanding of how the concept of citizen science is conceptualized and used by governments and authorities in select countries around the world.

Global Scale

Another article in this special issue looks at opportunities and barriers for citizen science in understanding and addressing global policy issues. In *Empowering Citizens to Inform Decision-Making as a Way Forward to Support Invasive Alien Species Policy*, Quentin J. Groom, Diederik Strubbe, Tim Adriaens, Amy J.S. Davis, Peter Desmet, Damiano Oldoni, Lien Reyserhove, Helen Roy, and Sonia Vanderhoeven propose solutions – through both social and technological innovation – to deliver tailored and "fit for use" policy-relevant information to allow for greater mutual understanding and uptake of citizen science evidence in policy within both the European and global contexts.

Multi-national Scale

At the regional scale, in their article *Understanding the Citizen Science Landscape for Environmental Policy: An Assessment and Recommendations*, Anne Turbé, Jorge Barba, Maite Pelacho, Chrysa Tsinarki, Francisco Sanz, Fermin Serrano-Sanz, Shailendra Mugdal, Lucy D. Robinson, Jose-Miguel Rubio, and Sven Schade conduct and describe an assessment and analysis of the contributions of citizen science to environmental policy in Europe. They suggest characteristics of citizen science projects that support policy linkages and explore barriers and opportunities for increasing the policy impact of citizen science.

State and National Scale

This issue also provides reflections at state and national scales, with articles that explore the context for citizen science and crowdsourcing in state and federal governments, including insights about the events and initiatives that shaped the conversation. In *Adopting Citizen Science as a Tool to Enhance Monitoring for an Environment Agency*, Erin Roger, Eren Turak, and Patrick Tegart make the case for the role of citizen science in New South Wales' (NSW) Government of Australia, and describe the creation of a citizen science program and the development and implementation of a citizen science strategy. They particularly highlight organizational challenges.

Local Scale

Complementing the above, this special issue delves into the local context through two articles that describe examples of both creative and effective use of citizen science to address local problems. In *Wild Carrot (Daucus carota) Management in the Dungeness Valley, Washington, United States: The Power of Citizen Scientists to Leverage Policy Change*, Clea Rome and Cathy Lucero describe the role of Master Gardeners in shaping local policy on roadside weed management. In *All Hands on Deck: Local Ecological Knowledge and Expert Volunteers Contribute to the First Delisting of a Marine Fish Species Under the Endangered Species Act*, Kelly S. Andrews, Krista M. Nichols, Chris J. Harvey, Nick Tolimieri, Adam K. Obaza, Ron Garner, and Daniel M. Tonnes present a case where a cooperative research program involving the recreational fishing community resulted in knowledge that triggered a change to a public policy decision – a notable delisting of a species of rockfish under the Endangered Species Act.

Final Notes

The manuscripts in this volume provide a rich source of analysis of the contributions and impact of citizen science and crowdsourcing on public policy and offer strategies for public policy to facilitate citizen science. A second set of manuscripts will be added to this standing Special Issue on Policy Perspectives in early 2020, and then subsequently on a rolling basis.

As editors of this Special Issue, we encouraged and wanted to include manuscripts that cover a range of geographies and scales of interaction, spanning from the local and regional to national and global levels. That said, the issue is noticeably missing articles representing citizen science and crowdsourcing policy-related projects from Asia, South America, Africa, and indigenous nations around the world. We hope that this may be rectified in future issues of the journal.

We hope that the contributions in this special issue will not only demonstrate good practice for how citizen science may inform public policy, but also encourage citizen science project coordinators to consider how their projects may strategically provide the evidence-base for management and policy decisions.

Competing Interests

The authors have no competing interests to declare.

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