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Abstract	This white paper details the potential of citizen science to foster innovation in science, from a sociological and political perspective based on the work carried out through the ACTION project and activities of projects during the ACTION Accelerator.
Keywords	Citizen science, Accelerator model, Mentoring, Co-design, science innovation, White Paper

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EXECUTIVE SUMMARY

This White Paper explores the potential for learning from, and the practice of, citizen science to foster innovation in science. Citizen science, operating both within and outside of established research organisations and engaging with civil society has the potential to feed back into science not only in terms of social aspects of how and by whom science is done, but also in terms of impact on the concrete outcomes of scientific research. This document takes a sociological and political perspective on the opportunities offered by citizen science for facing existing challenges within the practice of science. It aims to communicate to scientific researchers and policymakers involved in citizen science the under-explored potential for innovation within scientific practice from advances made in the practice of citizen science.

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1. Introduction

Citizen science has, in recent years, become firmly entrenched in research practice, popular not only in terms of data gathering and processing beyond the reaches of the academy, but also as a method by which communities are able to argue for citizens' rights (Kimura and Kinchy, 2016).

This increased accessibility of the tools of research and knowledge production by those outside of traditional research environments falls within a broader contemporary trend of democratisation of knowledge-making (Rubio and Baert, 2013) and increased productive participation (e.g: König, 2013). This has its roots in the socio-political changes of the late 60s, particularly in the West, which gave rise to increased participatory engagement – with variable effectiveness – in a broad swathe of realms that had hitherto been the purview of experts, including design, action research and decision-making (Fuad-Luke, 2009; Polletta, 2016). The core sciences caught up later (Harris, 2020), particularly when Web2.0 facilitated the development of new types of community and sharing (Dawson et al., 2015).

During this time there has been a great deal of knowledge transfer out of science into citizen science, including communication and opening of scientific data and results, sharing methods and best practice, and more recently practices of reflection and evaluation (Vohland et al., 2021). Knowledge has also fed back to the scientific community through both formalised and informal channels, often relating to specific topics and practices (Harris, 2020). Most commonly acknowledged is the contribution of citizen science to the content of scientific research through, for example, data collection and analysis (e.g: Toerpe, 2013).

However, there are additional, wider-reaching implications of citizen science for science. In this white paper, we address explicitly the potential for citizen science practices to bring innovation into scientific research.

This white paper is produced within the framework of the ACTION project, a H2020 funded research project with the aim to transform citizen science to be more participatory, inclusive and citizen-led. The ACTION project, over the course of three years, has created methodologies, tools and guidelines that help to democratise the scientific process.

The topical focus of ACTION and the citizen science projects it has supported has been pollution. The learning shared in this white paper derives from experience of citizen science projects that address the environment and human-environment / land relations. Here we synthesise learning from the ACTION Accelerator projects in the context of current political and sociological consequences of the rise of citizen science. The ACTION Accelerator supported 16 diverse CS projects focussed on pollution over the course of 3 years. Central to the Accelerator methodology was the support and study of CS projects through a transdisciplinary lens, drawing on participatory research, co-design methods and

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STS (Science and Technology Studies). Through regular calls and reporting, alongside feedback and structured conversations, the ACTION Accelerator projects have been understood both as participatory research projects with an envrionmental pollution focus, and as sociologically and culturally relevant endeavours situated within broader trends in the politics of knowledge production. In this context, the potential contribution that learning from the practice of citizen science can make to science and the academy has been identified from a sociological and political perspective.

2. Science Innovation through Citizen Science

To foster innovation in science, citizen science should clearly demonstrate its scientific benefits, branch across disciplines, and promote active networking and new forms of collaboration (e.g: Hecker et al., 2018). However, the value of innovations that citizen science brings to science is highly debated both inside and outside the citizen science and scientific communities. One reason for this is that science is not without its problems. Inherent issues within the practice of science are exacerbated by the notion from within science that science exists autonomously, divorced from the political sphere, such that innovation in sociological and political areas of science are comparatively neglected (Rubio and Baert, 2013).

Before the pandemic hit, a group of scientists were convened by Scientific American editors for a policy feature that highlighted a few of the discipline's shortcomings ("How to Fix Science," 2018), highlighting issues such as sexual harassment, lack of interdisciplinarity, a broken funding system and the problem of reproducibility. Here we argue that activities at the cutting edge of citizen science may hold the potential both to inform scientific practice, and to address the public crisis of trust in science and evidence-based policymaking. This white paper therefore focuses primarily on often neglected opportunities for innovation in the practice of science through learning from the practice of citizen science activities.

2.1 Organisational methods

Traditionally, scientific research has been carried out by three main organisational types: universities, research institutions and industry. These comparatively well-resourced organisational types are able to dedicate significant funds to support the purchasing of equipment, maintenance, research infrastructure (such as library services, IT infrastructure, laboratories and technical staff, specialist equipment production, storage, archiving, publicity and communications) and to provide stability for some research positions. In the case of universities and research institutions, stable research positions are usually limited to tenured staff – lecturers, technicians, senior researchers – with a large proportion of the research work carried out by Ph.D. students and post-docs working on fixed term contracts linked to external funding.

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The institutions themselves are often considered to be neutral, yet power dynamics are inherent in organisational structures (Acker, 1990). The organisational structures of science are often hierarchical (Fox, 2006), and there is a multitude of inequalities inherent in the model (Rubio and Baert, 2013), including increased precarity for those on fixed term contracts compared to tenured positions, which has been exacerbated by the COVID-19 pandemic (Ahmed et al., 2020; Górska et al., 2021). The hierarchical nature of scientific organisations has been shown to risk perpetuating gender and racial stratification, which impacts on the way that science is done and the interpretation of research outcomes (Fox, 2006). Furthermore, gender and racial stratification in the workplace can increase the prevalence of discrimination and sexual harassment (Roscigno, 2019). Addressing institutional power dynamics inherent in existing organisational structures has the potential to impact not only the way that knowledge is shared but, crucially, also to help address existential struggles faced by young researchers, for instance by addressing the imbalance in benefit derived from collaborations between more and less powerful collaborators (Bruner and O'Connor, 2018).

The topic of organisational structure in citizen science remains largely unexplored in the research literature, but various types of non-hierarchical or decentralised organisational structures are documented (e.g: Regalado, 2017) and have an impact on the type of research and work carried out, as well as the possibility for collaboration across projects. For example the Temporary Autonomous Laboratories that emerge from the rhizomic Hackteria network, such as the Wormolution TAL which gathered practitioners to explore plastic materiality (Hackteria, 2019) are an opportunity for experimentation and development of new approaches to a problem through non-hierarchical self-organisation (Magrini, 2014).

The Open Soil Atlas project, which was supported in the second round of the ACTION Accelerator, was run as a sociocracy, where activities and their requisite responsibilities are organised in overlapping "circles" with the people who wish to participate volunteering to be part of the circle. Rather than following a hierarchical structure, decisions within a sociocracy are taken only when consensus is achieved. This process can impact on the speed at which a project progresses and can even lead to stagnation of the project, though the risk can be somewhat mitigated by careful attention to the process. If successfully implemented, sociocracy can facilitate both social sustainability of an undertaking and knowledge-sharing (Jorna and Rommes, 2006), both of which are important aspects of citizen science and to scientific research.

2.2 Approaches to diversity and inclusion

Despite continued work on diversity and inclusion in science, the statistics continue to fall short of being representative of populations at large (e.g: Fadeyi et al., 2020). This is partly because of the lower rates of applications, lower retention rate of POCs in academia, and (unconscious) biasses at the hiring stage (Swartz et al., 2019). Approaches to equity,

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diversity and inclusion (EDI) in participatory science projects are similarly early-stage. However, measures to include underrepresented citizens in participatory research overall are increasing and have the potential to open up scientific research as a whole – both in citizen science and in formal research settings – to underrepresented groups.

Projects from the ACTION citizen science cohort have addressed marginalised and underrepresented groups in a number of ways that focus on the specific benefits to the research of engaging these groups:

- engaging with citizens as providers of specialist knowledge about either a location or practices, including significant feedback to the citizens of the project outputs (In My Backyard, Water Sentinels, Open Soil Atlas, WOW Nature, Noise Maps)
- engaging with citizens with access to specific locations / as landscape stewards (WOW Nature, Water Sentinels, In My Backyard)
- engaging with groups with specialised sensory experiences (Sonic Kayaks)

Other projects have engaged marginalised groups without specific topical focus:

- engaging with groups of young people and refugees (CityComPlastic)

Though comprehensive longitudinal studies of the effect of engaging in citizen science on the likelihood of pursuing a professional scientific career are scarce, engagement with informal science has been shown to have a positive effect on scientific career motivations in young people (Urválková and Janoušková, 2019). Initiatives where there is a strong degree of co-creation in the study, not only increase the legibility of science and scientific practice to those involved, they also can increase skills and interest in science in the citizen scientists involved (Skarlatidou et al., 2019).

2.3 Challenging Colonialism in Science

An emerging criticism that has recently been levelled at science, particularly environmental and geosciences, is that their practice perpetuates a colonial relationship to land and landscape (Liboiron, 2021, 2017). Colonial attitudes see nature as “other” to humans, and relate to land as property from which wealth, by exploitation of resources, can be derived (Liboiron, 2021). Within this frame, citizen science practices offer the opportunity to address criticisms of colonialism in science deemed to be echoes of colonialism inherited from colonial-era scientific exploration.

Citizen science is situated within a cultural trend that shifts the boundaries of who is – and who isn’t – considered as a viable contributor in producing knowledge, sometimes called the democratisation of knowledge-making, which is accompanied by changes to how authority is bestowed onto knowledge (Rubio and Baert, 2013). Both Regalado (2017), and Liboiron (2021a) argue that “citizens” from outside the academy, when involved in science, can challenge hidden colonial echoes in scientific practice.

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The inclusion of traditional ecological knowledge has been argued to lead to innovation in science, for instance driving discoveries in pharmaceuticals and ecology (Kimmerer, 2002; Walajahi, 2019) to the extent that the IUCN (International Union for the Conservation of Nature) recognised its importance to conservation and biodiversity as early as 1986 (Berkes et al., 1995).

Addressing diversity and inclusion in (participatory) science (Section 2.2) is the first step towards questioning colonial assumptions. To address issues of colonialism in science that affect science innovation, perspectives from other knowledge traditions can be brought to the fore by structuring projects to allow multiple voices and perspectives to be heard and assessed for their relevance.

Two projects from the ACTION Accelerator have established methods by which to incorporate traditional and local knowledges from non-scientists into pollution research. In My Backyard carried out participatory action research and data collection with backyard gardeners and small-scale farmers to investigate and affect the use of chemical pesticides, herbicides and fertilizers at the border of a nature reserve in Portugal. Using a discursive methodology alongside online questionnaires, In My Backyard's mixed methods research allowed for gathering and sharing of traditional gardening methods alongside data on current practices. Also concerned with water pollution, Water Sentinels engaged with local experts to gather water samples to track pollution events on the Portuguese coast and to gather historical data of pollution events, carefully designing the sampling methodology to harness local knowledge and to facilitate participation in the research.

2.4 Reframing scientific research through participation

Citizen science projects, particularly those with citizen engagement at the start of the project, can reframe which questions are asked (Sauermann et al., 2020). The involvement of citizens brings motivations to do the research that are relevant to civil society, providing a mandate from which expectations, methods and research questions can be formulated, leading to transformative research approaches such as living lab strategies (for example TU Berlin's Reallabor), where solutions to societal problems are developed, tested and implemented in research processes (Bonn et al., 2021). Projects such as these also support the possibility of bringing citizens into participatory design processes for solutions and interventions in lived space.

Citizen science can also promote changes in how science is governed – to whom it is available, how the knowledge produced from it is understood, and how its excellence is judged – by showing how science can be treated as a commons (Pelacho et al., 2021).

ACTION Accelerator project Noise Maps engaged with citizens to map the soundscape of inner-city Barcelona. The project impetus came from citizens of the Raval district

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concerned about noise pollution who approached BitLab Cultural Cooperative with the idea to map Raval's soundscape. In partnership with Universitat Pompeu Fabra's Music Technology Group, the Ateneu de Fabricació Ciutat Meridiana FabLab and Raval Neighbourhood Association Network, the team and citizens gathered and analysed recordings from Raval, which resulted in both scientific results and policy recommendations.

Similarly, the idea behind Accelerator project CitiComPlastic came from civil society, when project organiser Nabolagshager was approached by a large local festival to address the high levels of compostable plastic waste generated by partygoers. The project mobilised citizen scientists to research how well bioplastic waste can be composted, as Oslo has no bioplastic waste management facilities. Results from the project have prompted further collaborations and scientific research on the topic.

The involvement of citizen scientists in research also changes the narratives around how science is carried out, challenging scientific stereotypes and embedding scientific thought into everyday life. Partly this is due to learning by doing – experience of the scientific process through citizen science projects makes scientific methods accessible to those lacking formal training (Bonney et al., 2009). This experiential understanding of what it means to gather evidence through scientific research can have a fundamental effect on trust in science and medicine, and its acceptance in policy and society.

2.5 Open Research

Open research has long been a priority of science policy, facilitated by the development of platforms through which scientific findings can be shared, such as the Open Science Framework, and the European Open Science Cloud, which is in its second stage of development.

Citizen science projects from ACTION have been shown to have high transformative potential in making science more open (Passani et al., 2021). In 2016, a set of guiding principles were instantiated with the aim to establish a standard for scientific data, ensuring that it is FAIR: Findable, Accessible, Interoperable and Reusable. CS projects provide an exemplary test-bed for the usability of open science infrastructure and for testing how FAIR research is. Non-specialists and volunteers are less likely to "work through" obfuscated or confusing datasets and technological quirks and difficulties; they are an unforgiving audience for collaborative platforms.

Working with non-specialist citizen scientists on open science allows for infrastructure to be developed that supports proper scientific method while streamlining processes, to foreground making sense of the science rather than overcoming technical barriers in data collection, processing or analysis, creating knowledge and knowhow that can also benefit scientific researchers.

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The Street Spectra project, one of the ACTION Accelerator case study projects, for instance, has developed a streamlined workflow that builds on existing platforms to allow citizen scientists to easily gather and analyse data on light coming from street lamps to contribute to a growing global map of lighting sources (Zamorano et al., 2021).

Citizen science activities can also lead to technological innovation, for instance in the development of low-cost sensors and their application to scientific questions, or refining machine learning algorithms (Franzen et al., 2021; Mazumdar et al., 2018).

2.6 Transdisciplinarity

The trend is science over the last century has broadly been towards hyperspecialisation. Different specialisations have developed different languages specific to their field meaning that cross-fertilisation of ideas, even within similar scientific disciplines, is very difficult and can result in "the creation of scholarly cul-de-sacs"(Castellani and Hafferty, 2009, p140). Alongside increasingly popular arts and science activities, citizen science has been lauded as offering a practical route to bringing more interdisciplinarity into science after this period of hyperspecialisation (Crain et al., 2014; Hecker et al., 2018). However, structural and institutional barriers, such as internal assessment frameworks, accounting structures and even physical accessibility to space, continue to rein in this potential (Frickel et al., 2019). ACTION projects have been shown to be highly interdisciplinary and have created new research fields (Passani et al., 2021). For instance, the Noise Maps project brought together technology development, sound studies and music research when exploring the soundscape of Barcelona. ACTION Accelerator Case Study Tatort Streetlight brings together light pollution, entomology, lighting engineers, and lighting industry in a citizen science project that holds the potential to make significant impact on insect decline through providing evidence on the impact implementing new, insect-friendly street lighting designs (Schroer et al., 2021). Cutting edge, bottom-up citizen science projects can provide a frame, funding, and location through which interdisciplinarity and transdisciplinary work can be realised.

3. Conclusions and Recommendations

The potential for citizen science to foster innovation in science is wide-ranging. In this White Paper, we have focussed on potential for innovation in addressing sociological and political aspects of scientific practice such as hyperspecialisation, relevance, interdisciplinarity, open science and EDI.

To optimise the potential of science innovation through citizen science, novel and cutting-edge citizen science practices need to be supported and fostered. Of particular import to fostering innovation is the support of citizen science activities that involve professional scientists where the frame of activity and responsibility for the projects' realisation lies

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outside the academy. Vital to these endeavours is the development of collaborative research platforms promoting FAIR citizen science research and further development of strong networks of practice in citizen science. In addressing the innovative potential in terms of scientific knowledge creation, concrete and focussed research projects that explicitly develop strategies for EDI in citizen science are particularly necessary and should be realised with contributions from social sciences and STS.

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References

Acker, J., 1990. HIERARCHIES, JOBS, BODIES: A Theory of Gendered Organizations. Gend. Soc. 4, 139–158. https://doi.org/10.1177/089124390004002002

Ahmed, M.A., Behbahani, A.H., Brückner, A., Charpentier, C.J., Morais, L.H., Mallory, S., Pool, A.-H., 2020. The precarious position of postdocs during COVID-19. Science 368, 957–958. https://doi.org/10.1126/science.abc5143

Berkes, F., Folke, Carl, Gadgil, M., 1995. Traditional Ecological Knowledge, Biodiversity, Resilience and Sustainability, in: Perrings, C.A., Mäler, K.-G., Folke, C., Holling, C.S., Jansson, B.-O. (Eds.), Biodiversity Conservation, Ecology, Economy & Environment. Springer Netherlands, Dordrecht, pp. 281–299. https://doi.org/10.1007/978-94-011-0277-3_15

Bonn, A., Brink, W., Hecker, S., , Herrmann, T.M., Liedtke, C., Premke-Kraus, M., Voigt-Heucke S., v. Gönner, J., Altmann, C., Bauhus, W., Bengtsson, L., Brandt, M., Bruckermann, T., Büermann, A., Dietrich, P., Dörler, D., Eich-Brod, R., Eichinger, M., Ferschinger, L., Freyberg, L., Grützner, A., Hammel, G., Heigl, F., Heyen, N.B., Hölker, F., Johannsen, C., Kiefer, S., Klan, F., Kluß, T., Kluttig, T., Knapp, V., Knobloch, J., Koop, M., Lorke, J., Munke, M., Mortega, K.G., Pathe, C., Richter, A., Schumann, A., Soßdorf, A., Stämpfli, T., Sturm, U., Thiel, C., Tönsmann, S., van den Bogaert, V., Valentin, A., Wagenknecht, K., Wegener, R., Woll, S., 2022. Citizen Science-Strategie 2030 für Deutschland.

Bonney, R., Cooper, C.B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K.V., Shirk, J., 2009. Citizen Science: A Developing Tool for Expanding Science Knowledge and Scientific Literacy. BioScience 59, 977–984. https://doi.org/10.1525/bio.2009.59.11.9

Bruner, J., O'Connor, C., 2018. Power, Bargaining, and Collaboration, in: Boyer-Kassem, T. (Ed.), Scientific Collaboration and Collective Knowledge. Oxford University Press, New York.

Castellani, B., Hafferty, F.W., 2009. Sociology and Complexity Science: A New Field of Inquiry, Understanding Complex Systems. Springer Berlin Heidelberg Springer e-books, Berlin, Heidelberg.

Crain, R., Cooper, C., Dickinson, J.L., 2014. Citizen Science: A Tool for Integrating Studies of Human and Natural Systems. Annu. Rev. Environ. Resour. 39, 641–665. https://doi.org/10.1146/annurev-environ-030713-154609

Dawson, G., Lintott, C., Shuttleworth, S., 2015. Constructing Scientific Communities: Citizen Science in the Nineteenth and Twenty-First Centuries. J. Vic. Cult. 20, 246–254. https://doi.org/10.1080/13555502.2015.1022053

Fadeyi, O.O., Heffern, M.C., Johnson, S.S., Townsend, S.D., 2020. What Comes Next? Simple Practices to Improve Diversity in Science. ACS Cent. Sci. 6, 1231–1240. https://doi.org/10.1021/acscentsci.0c00905

Fox, M.F., 2006. Gender, Hierarchy, and Science, in: Handbook of the Sociology of Gender, Handbooks of Sociology and Social Research. Springer US, pp. 441–457. https://doi.org/10.1007/0-387-36218-5_20

Franzen, M., Kloetzer, L., Ponti, M., Trojan, J., Vicens, J., 2021. Machine Learning in Citizen Science: Promises and Implications, in: Vohland, K., Land-Zandstra, A., Ceccaroni, L., Lemmens, R., Perelló, J., Ponti, M., Samson, R., Wagenknecht, K. (Eds.), The Science of Citizen Science. Springer International Publishing, Cham,

pp. 183–198. https://doi.org/10.1007/978-3-030-58278-4_10
Frickel, S., Albert, M., Prainsack, B. (Eds.), 2019. 9. Interdisciplinarity Reloaded? Drawing Lessons from “Citizen Science,” in: Investigating Interdisciplinary Collaboration. Rutgers University Press, pp. 194–212. https://doi.org/10.36019/9780813585918-012
Fuad-Luke, A., 2009. Design activism: beautiful strangeness for a sustainable world. Earthscan, London; Sterling, VA.
Górska, A.M., Kulicka, K., Staniszewska, Z., Dobija, D., 2021. Deepening inequalities: What did COVID−19 reveal about the gendered nature of academic work? Gend. Work Organ. 28, 1546–1561. https://doi.org/10.1111/gwao.12696
Hackteria, 2019. Wormolution Hackteria Temporary Autonomous Laboratory at 1000 Ecologies, Geneva. URL https://www.hackteria.org/wiki/Wormolution_-_Hackteria_Temporary_Autonomous_Laboratory_at_1000_Ecologies,_Geneva (accessed 1.10.22).
Harris, J., 2020. Science and Democracy Reconsidered. Engag. Sci. Technol. Soc. 6, 102–110. https://doi.org/10.17351/ests2020.383
Hecker, S., Bonney, R., Haklay, M., Hölker, F., Hofer, H., Goebel, C., Gold, M., Makuch, Z., Ponti, M., Richter, A., Robinson, L., Iglesias, J.R., Owen, R., Peltola, T., Sforzi, A., Shirk, J., Vogel, J., Vohland, K., Witt, T., Bonn, A., 2018. Innovation in Citizen Science – Perspectives on Science-Policy Advances. Citiz. Sci. Theory Pract. 3, 4. https://doi.org/10.5334/cstp.114
How to Fix Science, 2018. Sci. Am. 319, 50–51. https://doi.org/10.1038/scientificamerican1018-50
Jorna, R.J., Rommes, N., 2006. Sociocracy and the sustainability of knowledge: Reekx, Atol and Endenburg Elektrotechnics, in: Sustainable Innovation: The Organisational, Human and Knowledge Dimension. Routledge.
Kimmerer, R.W., 2002. Weaving Traditional Ecological Knowledge into Biological Education: A Call to Action. BioScience 52, 432. https://doi.org/10.1641/0006-3568(2002)052[0432:WTEKIB]2.0.CO;2
Kimura, A.H., Kinchy, A., 2016. Citizen Science: Probing the Virtues and Contexts of Participatory Research. Engag. Sci. Technol. Soc. 2, 331–361. https://doi.org/10.17351/ests2016.99
König, R., 2013. WIKIPEDIA: Between lay participation and elite knowledge representation. Inf. Commun. Soc. 16, 160–177. https://doi.org/10.1080/1369118X.2012.734319
Liboiron, M., 2021. Pollution is colonialism. Duke University Press, Durham.
Liboiron, M., 2017. Compromised Agency: The Case of BabyLegs. Engag. Sci. Technol. Soc. 3, 499–527. https://doi.org/10.17351/ests2017.126
Magrini, B., 2014. Hackteria: An Example of Neomodern Activism, in: Leonardo Electronic Almanac Book - Red Art: New Utopias in Data Capitalism 20.1. pp. 58–72.
Mazumdar, S., Ceccaroni, L., Piera, J., Hölker, F., Berre, A., Arlinghaus, R., Bowser, A., 2018. Citizen science technologies and new opportunities for participation, in: Citizen Science: Innovation in Open Science, Society and Policy. UCL Press, London, pp. 303–320.
Passani, A. Janssen, A., Forino, G. (2021), D6.4 Impact assessment report v2.
Pelacho, M., Rodríguez, H., Broncano, F., Kubus, R., García, F.S., Gavete, B., Lafuente, A., 2021. Science as a Commons: Improving the Governance of Knowledge

Through Citizen Science, in: Vohland, K., Land-Zandstra, A., Ceccaroni, L., Lemmens, R., Perelló, J., Ponti, M., Samson, R., Wagenknecht, K. (Eds.), The Science of Citizen Science. Springer International Publishing, Cham, pp. 57–78. https://doi.org/10.1007/978-3-030-58278-4_4

Polletta, F., 2016. Participatory enthusiasms: a recent history of citizen engagement initiatives. J. Civ. Soc. 12, 231–246. https://doi.org/10.1080/17448689.2016.1213505

Regalado, C., 2017. Getting Out of Their Way: Do-It-Yourselfers, Sensing, and Self-Reliance. Springer, Cham, pp. 273–298. https://doi.org/10.1007/978-3-319-25658-0_14

Roscigno, V.J., 2019. Discrimination, Sexual Harassment, and the Impact of Workplace Power. Socius Sociol. Res. Dyn. World 5, 237802311985389. https://doi.org/10.1177/2378023119853894

Rubio, F.D., Baert, P. (Eds.), 2013. The politics of knowledge, 1. issued in paperback. ed. Routledge, London.

Sauermann, H., Vohland, K., Antoniou, V., Balázs, B., Göbel, C., Karatzas, K., Mooney, P., Perelló, J., Ponti, M., Samson, R., Winter, S., 2020. Citizen science and sustainability transitions. Res. Policy 49, 103978. https://doi.org/10.1016/j.respol.2020.103978

Schroer, S., Austen, K., Moczek, N., Kalinkat, G., Jechow, A., Heller, S., Reinhard, J., Dehn, S., Wuthenow, C.I., Post-Stapelfeldt, M., van Grunsven, R.H.A., Pérez Vega, C., Schumacher, H., Kaanaa, L., Saathoff, B., Völker, S., Hölker, F., 2021. Towards Insect-Friendly Road Lighting—A Transdisciplinary Multi-Stakeholder Approach Involving Citizen Scientists. Insects 12, 1117. https://doi.org/10.3390/insects12121117

Skarlatidou, A., Suskevics, M., Göbel, C., Prūse, B., Tauginiené, L., Mascarenhas, A., Mazzonetto, M., Sheppard, A., Barrett, J., Haklay, M., Baruch, A., Moraitopoulou, E.-A., Austen, K., Baïz, I., Berditchevskaia, A., Berényi, E., Hoyte, S., Kleijssen, L., Kragh, G., Legris, M., Mansilla-Sanchez, A., Nold, C., Vitos, M., Wyszomirski, P., 2019. The Value of Stakeholder Mapping to Enhance Co-Creation in Citizen Science Initiatives. Citiz. Sci. Theory Pract. 4, 24. https://doi.org/10.5334/cstp.226

Swartz, T.H., Palermo, A.-G.S., Masur, S.K., Aberg, J.A., 2019. The Science and Value of Diversity: Closing the Gaps in Our Understanding of Inclusion and Diversity. J. Infect. Dis. 220, S33–S41. https://doi.org/10.1093/infdis/jiz174

Toerpe, K., 2013. The Rise of Citizen Science. Kosmos 44–47.

Urválková, E.S., Janoušková, S., 2019. Citizen science – bridging the gap between scientists and amateurs. Chem. Teach. Int. 1. https://doi.org/10.1515/cti-2018-0032

Vohland, K., Land-Zandstra, A., Ceccaroni, L., Lemmens, R., Perelló, J., Ponti, M., Samson, R., Wagenknecht, K. (Eds.), 2021. The Science of Citizen Science. Springer International Publishing, Cham. https://doi.org/10.1007/978-3-030-58278-4

Walajahi, H., 2019. Engaging the “Citizen” in Citizen Science: Who’s Actually Included? Am. J. Bioeth. 19, 31–33. https://doi.org/10.1080/15265161.2019.1619868

Zamorano, J, González R. & García, L. (2021), ACTION App: final version of one simple device to characterise street lamps spectra