Transdisciplinary Sustainability Research and Citizen Science: Options for Mutual Learning

Lisa Pettibone, Birgit Blättel-Mink, Bálint Balázs, Antonietta Di Giulio, Claudia Göbel, Katja Heubach, Diana Hummel, Johannes Lundershausen, Alexandra Lux, Thomas Potthast, Katrin Vohland, Carina Wyborn

Both citizen science and transdisciplinary sustainability research involve nonacademic actors in the production of knowledge while seeking to contribute to sustainability transitions, albeit in different ways. From citizen science, transdisciplinary researchers can learn about the multiple ways of engaging knowledge holders, and producing and sharing knowledge.

Transdisciplinary Sustainability Research and Citizen Science: Options for Mutual Learning
GAIA 27/2 (2018): 222–225 | **Keywords:** citizen science, co-design, co-dissemination, co-production, sustainability, transdisciplinary research

Sustainability science is a problem-oriented academic field that contributes to sustainability by applying transdisciplinary methods. The vision of *Future Earth,* a global research initiative, recognizes this approach, calling for a new type of science that links disciplines, knowledge systems and societal partners to support a more agile global innovation system (and foster sustainable development).[1] Within the *Future Earth* discourse, co-design, co-production and co-dissemination of knowledge are keywords to describe integrative research that aims to address these challenges (Mauser et al. 2013). Like sustainability science, citizen science (CS) is an approach to research that integrates nonacademic actors into research activities. Although not explicitly oriented towards sustainability outcomes, CS takes place in relevant areas, such as biodiversity and climate change.

Based on these similarities, we argue that transdisciplinary research (TDR) can learn from the experiences and potential of CS and vice versa. Here, we canvas lessons learned from these fields to contribute to the further development of sustainability science in *Future Earth*. We focus on three key challenges: *knowledge integration, quality criteria,* and *normativity* (see also Blättel-Mink et al. 2016). In doing so, we aim to stimulate exchange between the communities within *Future Earth,* transdisciplinary sustainability research and CS.[2]

Contact: *Dr. Lisa Pettibone* | Museum für Naturkunde – Leibniz Institute for Evolution and Biodiversity Science (MfN) | Invalidenstr. 43 | 10115 Berlin | Germany | lisa.pettibone@mfn.berlin

Prof. Dr. Birgit Blättel-Mink | Goethe University Frankfurt am Main | Department of Social Sciences | Frankfurt am Main | Germany | b.blaettel-mink@soz.uni-frankfurt.de

Citizen Science – Uncovering the Potential of Societal Actors

The need for actionable knowledge to address societal challenges and better epistemic governance of science has created high hopes for CS and scientific citizenship. CS, a specific form of public participation in scientific research, includes centuries-long traditions of what is often called "amateur research" in the fields of biology, astronomy and local history as well as relatively new projects that use digital technology to allow for distributed data collection and analysis (Bonney et al. 2009, Pettibone et al. 2016, Pettibone et al. 2017). CS includes approaches that may transcend disciplines (Crain et al. 2014) to address diverse goals, from individual curiosity to protection of biodiversity (Kullenberg and Kasperowski 2016, Pettibone et al. 2017). CS projects practice diverse approaches to co-design, co-production and co-dissemination relevant also to transdisciplinary sustainability science.

Key Challenges of Transdisciplinary Sustainability Research

There are three key issues of concern to transdisciplinary sustainability research that are also relevant for CS (Blättel-Mink et al. 2016): 1. *knowledge integration,* in particular approaches that consider heterogeneous epistemic practices in knowledge produc-

https://doi.org/10.14512/gaia.27.2.9

tion, 2. *quality* criteria for assessing the different aspects of the research process, and 3. *normativity* issues concerning how deliberation among project partners takes into account different norms and values and how this shapes the research process.

Knowledge Integration

Co-design, co-production and co-dissemination focus upon joint efforts between scientific and societal actors (Beck et al. 2014, Mauser et al. 2013).[3] But how exactly to establish cooperation in research processes has not been sufficiently discussed. Two questions highlight the potential for mutual learning: who is involved, that is, inclusion and exclusion, and how to deal with different kinds of knowledge.

In TDR, inclusion is criteria-based: bound to expertise and dependent on invitation by project coordinators (mostly professional researchers). The selection of participants often applies methods to determine who relevant knowledge holders are (Bergmann et al. 2012). CS, by contrast, offers what we call an "opportunity-based approach": in most initiatives, anybody can join a given project; each participant is able to contribute to the generation of new knowledge. Depending on the project design, citizen scientists' role ranges from conducting independent research on local phenomena and providing field observations to analyzing digital media, as well as building knowledge bases from independent wikis to international databases such as the *Global Biodiversity Informational Facility* (Pettibone et al. 2017). This openness is possible because in most CS approaches, "citizens" are an implicit category, a catch-all term (Pettibone 2015) synonymous with layperson or volunteer. Thus, TDR is more sensitive to challenges of selection for participation, while CS's more open approach allows all comers to participate.

Successful collaboration in TDR requires distinguishing between and integrating different kinds of knowledge (e. g., Defila and Di Giulio 2015). Recent research, however, indicates that transdisciplinary projects usually integrate nonscientific knowledge in reaching out to societal actors to develop interventions, but not to involve them in reflecting the final results (Di Giulio et al. 2016). This may be because researchers lack the tools to judge the reliability of knowledge that has not been scientifically validated (Defila and Di Giulio 2015). CS, on the other hand, does not stress the integration of different kinds of knowledge, but focuses on the generation of new knowledge by involved citizens – be it as supportive data collection for the academic research of professional scientists (Bonney et al. 2009) or as citizen-driven research in areas of interest (Ottinger 2009). For both approaches, standards enforced through scientific norms play a crucial role in managing knowledge production with somewhat wider participation in CS (Dickel 2016).

Reflecting on these different approaches reveals avenues for mutual learning: exploring the epistemological mechanisms at play in CS could help TDR scholars better understand how knowledge that is perceived as scientifically sound can be generated with broader societal involvement and what assumptions such processes rely on. CS in turn could benefit from considering methods for knowledge integration to achieve more intentional plurality regarding the types of knowledge involved.

Quality Criteria

Since transdisciplinarity complements disciplinary and interdisciplinary routines in producing new knowledge that is both societally and scientifically relevant and robust, the criteria used to measure quality have long been a subject of fierce discussion. Quality criteria should refer to the different tasks in co-design, co-production and co-dissemination. Belcher et al.'s (2015) review of the principles and criteria for a multi-criteria assessment of TDR highlights specific qualities in different phases: relevance of the research problem, legitimacy of the research process, credibility of results and the effectiveness of the outcome. Jahn and Keil (2015) address quality assurance in TDR in three fields: the research problem, the research process, and research results. Defila and Di Giulio (1999) focus on external evaluation, identifying aspects to be considered across different phases of evaluation (ex-ante, intermediary, ex-post). An ex-ante evaluation would include description of the problem, project goals and research questions, involvement of nonacademic partners and methods of knowledge integration, while ex-post evaluation criteria cover the development of outputs and dissemination.

These three approaches to quality criteria for TDR (and there are many others) follow different objectives and aim at different contexts of usage. They provide assistance to those designing, assessing the reliability of or evaluating transdisciplinary processes. Altogether they provide ways to capture process quality, requirements for results and the overall performance of transdisciplinary projects.

Similar discussions on quality criteria are emerging in CS and suggest comparable levels of controversy (e. g., Heigl et al. 2018). Debates center around policy or scientific outcomes (e. g., Schmeller et al. 2009), data accessibility (Groom et al. 2016) and evaluation of the learning benefits for participants (e. g., Brossard et al. 2005), in terms of education, engagement in environmental or other issues and scientific or civic empowerment. There seems to be a trade-off between focusing on scientific, policy or educational goals in CS projects (Chase and Levine 2015). As with the debate in transdisciplinarity, the various quality criteria suggested in CS highlight diverse and sometimes competing goals. Despite this, discussions on quality criteria in CS tend to concentrate on areas of practical application, for example, justifying usability of data for science/policy and educational value. >

1 *www.futureearth.org/news/future-earth-2025-vision-sets-framework-programmes-contribution-global-sustainable-development*

2 This article is a direct outcome of the German *Future Earth* Committee working group *Co-Design, Co-Production and Co-Dissemination*, which met from 2014 to 2016 to discuss how citizen science and transdisciplinarity understand "co" in sustainability research. The co-authors are all members of the working group or external experts called in to discuss the subject at a roundtable organized by the working group in Berlin in June 2016.

3 The "co" indicates that academic and nonacademic actors work together on an equal footing.

CS can learn from the debate in TDR that different contexts and goals make it unlikely that one unified approach can be agreed upon. Choosing appropriate criteria may thus depend on the project's objectives and its normative orientations (e.g., policy-, education- or science-focused). TDR in turn might be enriched by consideration of benefits to participants as seen in CS. Finally, both TDR and CS should experiment with decision-making processes to determine relevant quality criteria at the project level and beyond.

Normativity

TDR is often characterised as solution-oriented, transformative and participatory. These attributes point to the threefold ambition of TDR to produce knowledge that is also relevant beyond academia, that positively impacts socio-ecological systems and that opens the often "closed club" of science. All of these ambitions include normative considerations, with which CS, perhaps by virtue of its popularity in the natural sciences, has engaged less than TDR. But even in TDR, different dimensions of normativity often lack reflection. This is particularly the case in the co-design stage, where agenda-setting takes place. The often neglected dimensions include 1. the communication of underlying normative agendas, 2. open deliberation about (presumed) consensus and conflicting issues, and 3. research practices that can deal with contested and conflicting norms.

First, if taken seriously, the issue of normativity in TDR goes beyond the merely instrumental aims of devising solutions to perceived problems, which uses an ideal-typical conceptualization of value-neutral science. More than other forms of research, TDR itself needs to be understood as a normative instrument, that means as part of an explicitly transformative political agenda. Normativity therefore extends beyond epistemological issues of good scientific practice into the moral and political arena (Potthast 2015). The same is true for CS, which is linked to normative goals such as enhancing the quality of science, empowering nonscientists and achieving sustainability.

Second, a simplistic integration of different disciplines, methods, conceptual understandings and scientific approaches ignores power relations and social inequalities that affect citizenship (Melo-Escrihuela 2008). While integration is necessary for TDR, a simplistic mode of integrating lay knowledges into dominant scientific frames threatens the plurality of epistemic approaches to knowledge production, which both TDR as well as CS often claim as their strength. Both approaches need to be more sensitive to how knowledge is integrated and on whose terms.

Third, established processes of research governance and management, which can inhibit transdisciplinarity and citizen participation in science, can only be addressed if their guiding norms are opened up for discussion. Establishing quality criteria is an evaluative and normative issue in itself, as discussed above. To the extent that research governance frameworks are insufficient for transdisciplinarity and CS, different criteria need to be employed to monitor and evaluate projects in a way that promotes the qualities espoused by these approaches.

TDR and CS have much to learn with respect to normativity in research. CS can learn from transdisciplinarity's deliberative approach, which allows it to understand issues of normativity and epistemic quality as integral to open research, as well as its contested problem-framing and the implications of participation as a value in and of itself. In turn, CS can share its experiences of doing science, which is a diverse practice when preformed in a participatory way and suggests multiple modes of knowledge production that are mutually embedded in science and other parts of society.

Conclusions

Implementing transdisciplinarity as a model of sustainability research poses a variety of challenges: inclusion of nonacademic actors throughout the research process, integration of different types of knowledge and worldviews, development of appropriate quality criteria and sensitivity to normativity. We have identified areas of mutual learning to address these challenges. From CS, transdisciplinary researchers can learn about the diversity of ways to engage knowledge holders, produce and share knowledge. We argue that this richness of practice can inspire participatory and TDR and thus provide new ideas of how to overcome the above challenges. At the same time, CS is no silver bullet. It often faces limited societal inclusion and precludes consideration of representation or normativity in the production of knowledge. Here, CS can – and should – examine lessons from TDR. In particular, the rich debates and experiences within transdisciplinarity related to quality criteria and consideration of normativity could greatly stimulate CS practice.

With these considerations in mind, we suggest that transdisciplinary sustainability research should strive to systematically integrate CS formats as types of participatory practice. In this way, different knowledge domains and expertise from various sectors of society can be included to enhance the innovation potential of *Future Earth* science.

The authors would like to thank the German Committee *Future Earth* for its support, the German Research Foundation (DFG) for funding the activities of the working group, as well as *Aletta Bonn* and the international and national experts who discussed with us at the expert roundtable held in June 2016. We are grateful to *Armin Grunwald,* member of the German Committee *Future Earth,* for advising the working group and commenting on this text.

References

Beck, S. et al. 2014. Towards a reflexive turn in global environmental expertise – The cases of the IPCC and IPBES. *GAIA* 23/2: 80–87.

Belcher, B. M., K. E. Rasmussen, M. R. Kemshaw, D. A. Zornes. 2015. Defining and assessing research quality in a transdisciplinary context. *Research Evaluation.* DOI: 10.1093/reseval/rvv025.

Bergmann, M., T. Jahn, T. Knobloch, W. Krohn, C. Pohl, E. Schramm. 2012. *Methods for transdisciplinary research. A primer to practice.* Frankfurt am Main: Campus.

Blättel-Mink, B. et al. 2016. *Report of DFG round table discussion on co-design, co-production and co-dissemination.* Working group report to the German Committee *Future Earth*.

Bonney, R. et al. 2009. Citizen science: A developing tool for expanding science knowledge and scientific literacy. *BioScience* 59/11: 977–984.

Brossard, D., B. Lewenstein, R. Bonney. 2005. Scientific knowledge and attitude change: The impact of a citizen science project. *International Journal of Science Education* 27: 1099–1121.

Chase, S. K., A. Levine. 2015. A framework for evaluating and designing citizen science programs for natural resources monitoring. *Conservation Biology* 30: 456–466.

Crain, R., C. Cooper, J. L. Dickinson. 2014. Citizen science: A tool for integrating studies of human and natural systems. *Annual Review of Environment and Resources* 39: 641–665.

Defila, R., A. Di Giulio. 1999. Evaluating transdisciplinary research – Evaluation criteria for inter- and transdisciplinary research. *Panorama.* Special Issue 1/99.

Defila R., A. Di Giulio. 2015. Integrating knowledge: Challenges raised by the "Inventory of Synthesis". *Futures* 65: 123–135. DOI: 10.1016/j.futures.2014.10.013.

Di Giulio, A., R. Defila, T. Brückmann. 2016. "Das ist halt das eine ... Praxis, das andere ist Theorie" – Prinzipien transdisziplinärer Zusammenarbeit im Forschungsalltag. In: *Transdisziplinär forschen – zwischen Ideal und gelebter Praxis. Hotspots, Geschichten, Wirkungen.* Edited by R. Defila, A. Di Giulio. Frankfurt am Main: Campus. 189–286.

Dickel, S. 2016. Trust in technologies? Science after de-professionalization. *Journal of Science Communication* 15/5: C03.

Groom, Q., L. Weatherdon, I. R. Geijzendorffer. 2016. Is citizen science an open science in the case of biodiversity observations? *Journal of Applied Ecology* 54: 612–617.

Heigl, F. et al. 2018. *Quality criteria for citizen science projects on Österreich forscht. Report by the Citizen Science Network Austria working group on quality criteria.* https://zenodo.org/record/1161953#.WrC8LIIh3NB (accessed May 23, 2018).

Jahn, T., F. Keil. 2015. An actor-specific guideline for quality assurance in transdisciplinary research. *Futures* 65: 195–208.

Kullenberg, C., D. Kasperowski. 2016. What is citizen science? A scientometric meta-analysis. *PLOS One* 11/1: e0147152.

Mauser, W. et al. 2013. Transdisciplinary global change research: The co-creation of knowledge for sustainability. *Current Opinion in Environmental Sustainability* 5/3–4: 420–431.

Melo-Escrihuela, C. 2008. *Promoting ecological citizenship: Rights, duties and political agency.* ACME Editorial Collective, Keele University. citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.459.381&rep=rep1&type=pdf (accessed May 21, 2017).

Ottinger, G. 2009. Buckets of resistance: Standards and the effectiveness of citizen science. *Science, Technology, & Human Values* 35/2: 244–270.

Pettibone, L. 2015. Constructing "citizens" in the citizen science literature: Who are they and what do they do? Paper presented at the *Interpretive Policy Analysis Conference.* July 8–10, Lille, France.

Pettibone, L. et al. 2016. *Citizen science for all: A guide for citizen science practitioners.* www.buergerschaffenwissen.de/sites/default/files/grid/2017/11/20/handreichunga5_engl_web.pdf (accessed May 23, 2018).

Pettibone, L., K. Vohland, D. Ziegler. 2017. Understanding the (inter)disciplinary and institutional diversity of citizen science: A survey of current practice in Germany and Austria. *PLOS One* 12/6: e0178778.

Potthast, T. 2015. Ethics and sustainability science beyond Hume, Moore and Weber – Taking epistemic-moral hybrids seriously. In: *Ethics of science in the research for sustainable development.* Edited by S. Meisch, J. Lundershausen, L. Bossert, M. Rockoff. Baden-Baden: Nomos. 129–152.

Schmeller, D. S. et al. 2009. Advantages of volunteer-based biodiversity monitoring in Europe. *Conservation Biology* 23: 307–316.

Submitted November 29, 2017; revised version accepted March 20, 2018.

CONTRIBUTING AUTHORS

Dr. Lisa Pettibone
Museum für Naturkunde – Leibniz Institute for Evolution and Biodiversity Science (MfN), Berlin, Germany

Prof. Dr. Birgit Blättel-Mink
Goethe University Frankfurt am Main, Department of Social Sciences, Frankfurt am Main, Germany

Bálint Balázs
Environmental Social Science Research Group, Budapest, Hungary

Dr. Antonietta Di Giulio
Department of Environmental Sciences, University of Basel, Basel, Switzerland

Claudia Göbel, MA
Museum für Naturkunde - Leibniz Institute for Evolution and Biodiversity Science (MfN), Berlin, Germany

Dr. Katja Heubach
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn, Germany

PD Dr. Diana Hummel
ISOE – Institute for Social-Ecological Research, Frankfurt am Main, Germany

Johannes Lundershausen, MSc
Eberhard Karls Universität Tübingen, International Centre for Ethics in the Sciences and Humanities (IZEW), Tübingen, Germany

Dr. Alexandra Lux
ISOE – Institute for Social-Ecological Research, Frankfurt am Main, Germany

Prof. Dr. Thomas Potthast
Eberhard Karls Universität Tübingen, International Centre for Ethics in the Sciences and Humanities (IZEW), Tübingen, Germany

Dr. Katrin Vohland
Museum für Naturkunde – Leibniz Institute for Evolution and Biodiversity Science (MfN), Berlin, Germany

Dr. Carina Wyborn
Luc Hoffmann Institute, IUCN Conservation Centre, Gland, Switzerland, *and* Department of Society and Conservation, University of Montana, MT

Lisa Pettibone

Born 1981 in Alexandria, VA. Studies in film and public administration in New York and Washington, D. C., PhD in political science (Freie Universität Berlin). 2014 to 2016 coordinator of the citizen science capacity-building project *Citizens Create Knowledge (GEWISS)* at the Museum für Naturkunde Berlin. Co-speaker of the DKN *Future Earth* working group *Co-Design, Co-Production and Co-Dissemination*. Research interests: citizen science and participation, ideas in sustainability transformation.

Birgit Blättel-Mink

Born 1957 in Heidelberg, Germany. PhD in sociology (University of Heidelberg). Professor of sociology at the Department of Social Sciences at Goethe University Frankfurt am Main, Germany. Co-speaker of the DKN *Future Earth* working groups *Co-Design, Co-Production and Co-Dissemination* and *Social Innovations in Energy Policy Making*. Research interests: (social) innovation, sustainable development, gender (in)equality in higher education, transdisciplinarity.