



Citizen Science for the Sustainable Development Goals? The Perspective of German Citizen Science Practitioners on the Relationship between Citizen Science and the Sustainable Development Goals

CITIZEN SCIENCE:
THEORY AND PRACTICE

COLLECTION:
CONTRIBUTIONS OF
CITIZEN SCIENCE TO
THE UN SDGS

RESEARCH PAPER

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ABSTRACT

Conceptual models on the synergies between citizen science (CS) and the United Nations Sustainable Development Goals (SDGs) attribute an important role to CS in monitoring and supporting the achievement of the SDGs. However, recent research on the actual contribution of CS to the SDGs shows that it has so far fallen short of expectations. What previous research has largely neglected to investigate is how CS practitioners themselves view the synergies of CS and the SDGs, and whether the lack of initiative on their part could be a reason for CS's smaller-than-expected contribution to the SDGs. Therefore, we asked 81 CS practitioners in two separate surveys about which SDGs their research contributes to and how they assess the intersections between their research and the SDGs, as well as the synergies between the SDGs and CS in general. Our survey shows that the vast majority of CS practitioners in Germany see little overlap between their own research and the SDGs, while their assessment of the overall synergies between CS and the SDGs is slightly more positive. Likewise, our data indicates that some CS practitioners are not yet fully familiar with the SDG framework. Based on our findings, we conclude that CS support for the SDGs must still be considered a niche phenomenon in the German CS landscape, and suggest that the contribution of CS to the SDGs could be increased by publishing low-threshold SDG information materials and providing stronger opportunities for CS practitioners to participate in the future evolution of the SDG framework.

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INTRODUCTION

In 2015, the United Nations (UN) launched the 2030 Agenda for Sustainable Development, which outlines 17 Sustainable Development Goals (SDGs). Two years later, the potential contribution of citizen science (CS) to their definition, monitoring, and implementation was first explored in a discussion brief published by the Stockholm Environment Institute (West and Pateman 2017). In the intervening years, the discussion about the impact of CS on the SDGs has evolved into a research area with growing output, a designated European Union-funded Conference (Voigt-Heucke et al. 2021), and a special issue in a scientific journal (Dörler et al. 2021). Current research is primarily based on the premise that CS can make a significant contribution to the SDGs by helping to unleash the environmental and social transformations envisioned by the SDG agenda as a result of its democratic principles (Sauermann et al. 2020; Alarcon Ferrari et al. 2021). These principles are meant not only to meet the SDG agenda of “leaving no one behind,” but also to promote scientific productivity by engaging society in the research process. Based on these theoretical assumptions, various strands of scientific publications have emerged. For example, researchers have examined how CS project coordinators assess their support for the SDGs and the challenges they face in contributing to them (Moczek et al. 2021; Sprinks et al. 2021). In addition, studies have captured the actual and potential extent of various forms of contribution at the project, national, and global levels (Fritz et al. 2019; Shulla et al. 2020; Bishop et al. 2020; Schleicher and Schmidt 2020; Fraisl et al. 2020). Despite the progress of current research in evaluating the status quo of CS contribution to the SDGs, the practical challenges faced by CS projects, and different ways in which CS may assist the 2030 Agenda, there still appears to be a glaring gap in the literature regarding the essential question of how CS practitioners themselves view potential synergies between CS and the SDG framework. The perspective of CS practitioners must therefore be considered a desideratum—a desideratum we aim to address in this paper by providing insight into how CS practitioners from Germany assess the SDG framework.

We argue that exploring the perspectives of CS practitioners is, for two reasons, an essential step in realizing the full potential of CS to support the SDGs. First, although it is described in some papers as central to CS support for the SDGs (Fritz et al. 2019), current research still lacks evidence on CS practitioners’ perspectives on the SDG framework. Second, the low number of concrete CS contributions to the SDGs highlighted by Fraisl et al. (2020) and the findings of the Crowd4SDG consortium (Proden and Imaraliev 2021) suggest that CS still falls short of the high expectations placed on it in terms of SDG contribution.

The majority of publications on CS and the SDGs to date pursue one (or several) of the following three aims: (1) exploring potential future contributions, (2) taking stock of current contributions of CS projects to SDG monitoring, and (3) analyzing the practical reasons why CS does not yet play a relevant role in implementing the SDG framework.

- (1) The first type of paper is still quite prevalent in the field. Building on the aforementioned discussion brief by West and Pateman, several more recent publications have presented conceptual models of possible synergies between CS and the SDG framework on a global scale (Fritz et al. 2019; Sauermann et al. 2020; Shulla et al. 2020) or identified ways in which specific CS projects (or CS projects in a specific country or research field) could help implement the SDGs on the goal and/or target level (Koffler 2021; Queiruga-Dios et al. 2020; Ajates et al. 2020). Other researchers have proposed concrete CS-based approaches to collecting data or to leveraging existing datasets for specific SDG indicators. Examples include Josephine Head et al. (2020), who have developed toolkits for crowdsourced monitoring of five indicators related to soil health, and Isabel Bishop et al. (2020), who demonstrate how water quality data collected by the CS project Freshwater Watch in England and Zambia could be integrated into the official monitoring for indicator 6.3.2.
- (2) The first (and to date last) attempt at a systematic and exhaustive inventory of CS-generated data being used to monitor SDG indicators was undertaken in 2020 by Dilek Fraisl et al. (2020), who found that, at the time of the investigation, CS projects were contributing to the monitoring of 5 SDG indicators and had the potential to contribute to an additional 76 indicators. Since no up-to-date inventory similar in scope to the one compiled by Fraisl et al. (2020) exists, it is difficult to gauge how much progress has been made since 2020. A report published by the Crowd4SDG consortium in June 2021, however, gives some indication (Proden and Imaraliev 2021). According to this document, National Statistical Offices (NSOs) in the UK, Ghana, Colombia, the Philippines, and Kenya are currently exploring ways of leveraging CS-generated data for their SDG monitoring by integrating it as a form of nontraditional

or experimental statistics. Some have already prepared protocols and guidelines to facilitate this process and to provide some orientation to CS project coordinators intending to contribute to the monitoring of specific SDG indicators.

The UN Statistics Division itself is also in the process of producing guidelines and tool kits for both CS practitioners and statistics officials. In a Survey on the Implementation of the Cape Town Global Action Plan for Sustainable Development Data distributed to NSOs in August/September 2021, 26% of respondents indicated that they regard the use of “citizen-generated and crowd-sourced data” as a high priority for the next three years (The World Bank 2022). Nevertheless, official UN statistics and reports still reveal significant data gaps. For instance, of 193 countries or territories, only around one-fifth provide data relevant to SDG 13—climate action (United Nations 2022). Other SDGs with relatively low data availability include goals 2, 5, 11, 12, 14, and 16. In other words, there still is a lot of untapped potential when it comes to CS in support of the SDGs.

- (3) Several key challenges and obstacles have already been identified, including the lack of a legal and institutional framework for the integration of non-traditional statistics, problems with information and communication technology (ICT) infrastructure, doubts regarding the quality (e.g., in terms of balanced coverage or availability of metadata), and sustainability (i.e., continued sampling and guaranteed long-term access) of CS-generated data sources on the part of NSOs, methodological incompatibility, etc. (Proden and Imaraliev 2021; Bishop et al. 2020; de Sherbinin et al. 2021). In Germany, engagement with the SDGs is, as Lepenies and Zakari (2021) have pointed out, also hampered by a pronounced lack of interest on the part of policy-makers. Neither Germany’s national SDG strategy nor any of the other policy papers and official reports the authors analyzed draw a connection between Citizen Science and the SDGs. One potential impediment to closer cooperation between the CS community and SDG monitoring stakeholders is, however, only rarely mentioned in the literature—namely the CS projects themselves.

While a handful of papers cite lack of awareness or knowledge on the part of CS practitioners as one challenge

to be addressed (Fritz et al. 2019), very few researchers have attempted to investigate how CS project coordinators view the SGD framework and whether they are willing and prepared to actively gear their projects towards it. One such study was published by Sprinks et al. (2021): Based on 11 semi-structured interviews conducted by the authors with European CS project coordinators, it sheds light on the perceived benefits and challenges associated with assessing the impact of CS projects on sustainability goals. An online survey targeted at CS practitioners conducted by Moczek et al. (2021) found that, while a significant portion of respondents indicated that their project was already contributing or had the potential to contribute to one or several SDGs, a much smaller number reported that their project was actively sharing research data with relevant institutions. This suggests that, while many CS practitioners see a connection between their work and the sustainability goals, very few are contributing to SDG monitoring in a concrete and quantifiable way. A similar but more detailed and thus time-consuming survey launched by the Horizon 2020 project Crowd4SDG to capture perceptions of the SDG framework among CS practitioners received only 12 responses (compared with 144 respondents from the “official statistics community”) and thus did not yield viable results (Proden and Imaraliev 2021).

In short, the three different research aims defined at the beginning of this section are represented quite unequally in the literature. While theoretical or potential synergies between CS and the SDGs have been explored in numerous publications, information on actual contributions is much spottier. Of the papers that try to explain the gap between potential and actual contributions, very few draw on interviews or surveys to take into account the perspective of CS project coordinators. Moreover, the focus tends to be on identifying practical obstacles, such as a lack of resources, knowledge, or institutional support. One question remains largely unaddressed—to what extent project coordinators actually consider the SDG framework to be useful and relevant to their work. Answering that question would go a long way towards helping us develop strategies to encourage a more substantial and targeted contribution of CS to the SDGs.

In Germany, CS has been promoted politically and structurally in recent years by the Federal Ministry of Education and Research as well as other smaller funders. This has led to a thriving CS landscape. As of September 2022, there are already 215 projects listed on the German national CS platform (own data). Despite its large number of CS projects, there are few links between specific CS projects and the abstract goals of the SDGs in Germany. Lepenies and Zakari (2021), for example, surveyed all major German CS projects in the field of air quality monitoring

and did not find any evidence of concrete contributions to SDG implementation. In their view, the reason for this is not only a lack of support from statistical offices and policymakers but also the fact that the motivation to contribute to the SDGs within the CS community in Germany itself seems to be low. While these findings do not refute the assumption that CS could be very useful in advancing the SDG agenda, they highlight the need to develop strategies that encourage and enable CS practitioners to actively engage with the SDG framework and design their projects accordingly. These strategies must be based on solid knowledge of how CS practitioners themselves view potential synergies.

To support building an actor-centered knowledge base and thus emphasize the need for a more targeted contribution of CS to the SDGs in the long run, we conducted two structured surveys among German CS actors: First, we surveyed 42 participants of the annual German CS conference (Forum Citizen Science 2022), and second, we interviewed 39 project coordinators of CS projects listed on the German CS platform *Bürger schaffen Wissen* to ascertain how German CS practitioners perceive the interfaces between their research and the SDG framework, as well as the synergies between the SDGs and CS more generally.

To assess (a) the intersections between their research and the SDG framework and (b) the synergies they see between the SDGs and CS, we developed a set of baseline questions to systematically provide empirical evidence on CS practitioners' attitudes towards the SDG framework, which is lacking in the various present research foci:

- I. To complement the results of Schleicher and Schmidt's (2020) qualitative content analysis on potential SDG support by German CS projects with the self-assessment of German CS practitioners (similar to Moczek et al. 2021), we asked survey participants which SDG their project or research contributes to.
- II. For targeted support to the SDG agenda, CS practitioners need to draw impetus for their research from the SDGs. We argue that this is equally true for all contribution channels mentioned in the literature (Fritz et al. 2019; Sauermann et al. 2020; Shulla et al. 2020) and cannot be adequately captured by a matching approach based on qualitative content analysis (Schleicher and Schmidt 2020) that does not incorporate the personal opinions of CS practitioners. We therefore asked German CS practitioners whether (a) the SDGs are a guiding principle for their research and whether (b) the

SDGs significantly stimulate the conception of CS projects.

- III. Various papers have already pointed out the practical challenges associated with producing crowdsourced data for the monitoring of specific SDG indicators (Proden and Imaralieva 2021; Bishop et al. 2020; de Sherbinin et al. 2021). Some have even proposed more or less concrete solutions (Head et al. 2020; Bishop et al. 2020). The question remains, however, to what extent CS practitioners are interested in gearing their projects towards SDG monitoring. We know too little so far about whether CS practitioners include (a) indicators at all in the methodological design of their research or whether (b) participation formats in CS projects are targeted towards them.
- IV. Focusing on the external (Schleicher and Schmidt, 2020) and self-assessed (Moczek et al. 2021) contribution of CS projects to the SDGs has so far meant leaving aside the question of whether CS practitioners see sustainability research priorities adequately reflected in the SDGs. Against this backdrop, we asked German CS practitioners whether the (a) SDGs represent the core themes of sustainability research and whether (b) the SDGs adequately encompass the thematic span of citizen science sustainability engagement.

With this set of questions, we aimed to fill a knowledge gap to build an evidence-based bridge to foster synergies between abstract SDGs and hands-on CS practitioners.

METHODS

We conducted two different online surveys among CS practitioners in Germany using the German survey tool "SoSciSurvey" (<https://www.soscisurvey.de/>). First, we surveyed participants of the German CS conference, Forum Citizen Science 2022, "Global—Regional—Local: CS for the SDGs." The second survey targeted project coordinators who had not participated in the Forum Citizen Science 2022 and thus allowed us to control for potential biases that could stem from the circumstances in which the first survey was conducted (e.g., the context of a conference specifically dedicated to the SDGs). At the same time, this provided an opportunity to investigate whether a particular subset of the German CS community expresses a more positive attitude towards the SDG framework.

SURVEY AMONG CITIZEN SCIENCE PRACTITIONERS AT THE FORUM CITIZEN SCIENCE 2022

The target audience of our first survey was attendees of the German CS conference Forum Citizen Science 2022, which took place in May 2022. Over the past five years, the Forum Citizen Science has established itself as the most important annual event of the German CS community. Because the conference language is German, it is almost exclusively attended by German CS practitioners. The survey was integrated into the online conference evaluation and was open to all participants. Although all conference participants were able to take part in the survey, the questions on the SDGs relevant to this study were primarily directed at (potential) CS practitioners. By CS practitioners, we mean individuals who are already actively leading CS projects or are interested in becoming involved in a leadership capacity in CS projects in the future. Because not all Forum Citizen Science participants filled such a role or intend to do so in the future, not all data collected in the survey were usable. Since we were specifically interested in the opinion of (potential) project coordinators, and German CS projects are primarily coordinated by scientists, our analysis only included responses from people who classified themselves as scientists with an interest in CS or as scientists currently active in CS.

SURVEY AMONG GERMAN CITIZEN SCIENCE PROJECT COORDINATORS

As outlined above, we carried out a second survey consisting of an identical set of questions targeting CS project coordinators affiliated with the German CS platform *Bürger schaffen Wissen* to counteract any bias potentially resulting from the circumstances under which the first survey was conducted. This second survey was circulated through the email contacts of the project coordinators.

While one of the 7 research questions outlined in the introduction was presented individually, the remaining 6 were combined into 2 question blocks of 3 questions each. In a single multiple-choice question, participants were first asked to indicate which SDGs their project contributes to, as outlined in question 1. We present the results of this question in the subsection Contribution to the SDGs. The questions listed in 2–4 in the introduction were combined into two different blocks of questions. The results of the first block of questions, focusing on the (a) intersections between (their) research and the SDG framework, are summarized in the subsection Intersections of research and SDGs of the results section. Participants were asked II) how the SDGs impact their research questions, III) how the SDG indicators impact their research methods, and IV) how they view the correlation between sustainability research in general and the SDGs. The second block of questions addressed (b) the synergies that CS practitioners see between the SDGs and CS in general. The

results are reflected in the subsection Synergies between CS and the SDGs of the results section. Similar to the questions in the previous block, CS practitioners were asked about their perceptions of II) the influence of the SDGs on the creation of CS projects, III) the influence of SDG indicators on CS participation formats, and IV) whether the SDGs sufficiently cover CS sustainability engagement. In both question blocks, participants could indicate their attitudes on a 5-point Likert scale, with a fallback option of “do not know.”

STATISTICS

Since the pooled sample size was not large enough to further investigate differences in the responses of the two survey groups using robust inferential statistical methods, we limited our analysis to descriptive statistics. The participants' response behavior is described in percentages and is structured according to the question categories outlined in this section. All graphs and analyses in this study were created and performed with R.Studio.

RESULTS

Fifty-nine people participated in the survey conducted as part of the Forum Citizen Science 2022. Narrowing the data set to active and potential CS project coordinators reduced the sample size from the original 59 to 42. Fifty CS practitioners participated in the survey on the German Citizen Science platform *Bürger schaffen Wissen*. This represented exactly $\frac{1}{4}$ of the *Bürger schaffen Wissen* project coordinators at the time of the study. Of this second group, 9 respondents reported having participated in the Forum Citizen Science, so they had to be removed from the sample to avoid possible overlap. Together with the exclusion of two cases that did not answer any questions, this step reduced the sample size from 50 to 39.

CONTRIBUTION TO THE SUSTAINABLE DEVELOPMENT GOALS

Figures 1 and 2 show the results of the participants' self-assessment of the contribution of their research to the SDGs. They illustrate that in both surveys, SDG 4, Quality Education; SDG 11, Sustainable Cities and Communities; SDG 13, Climate Action; and SDG 15, Living on Land were mentioned most frequently. However, the order differs in one significant respect. Forum Citizen Science participants mentioned SDG 4 most frequently, at 73.8%. By contrast, among project coordinators on the platform, it ranked last among the four most frequently cited SDGs, at 33.3%.

The order and percentage of mentions of SDG 11, Sustainable Cities and Communities; SDG 13, Climate Action; and SDG 15, Life on Land, were quite comparable, with 47.6%, 40.5%, and 33.3%, respectively, in the

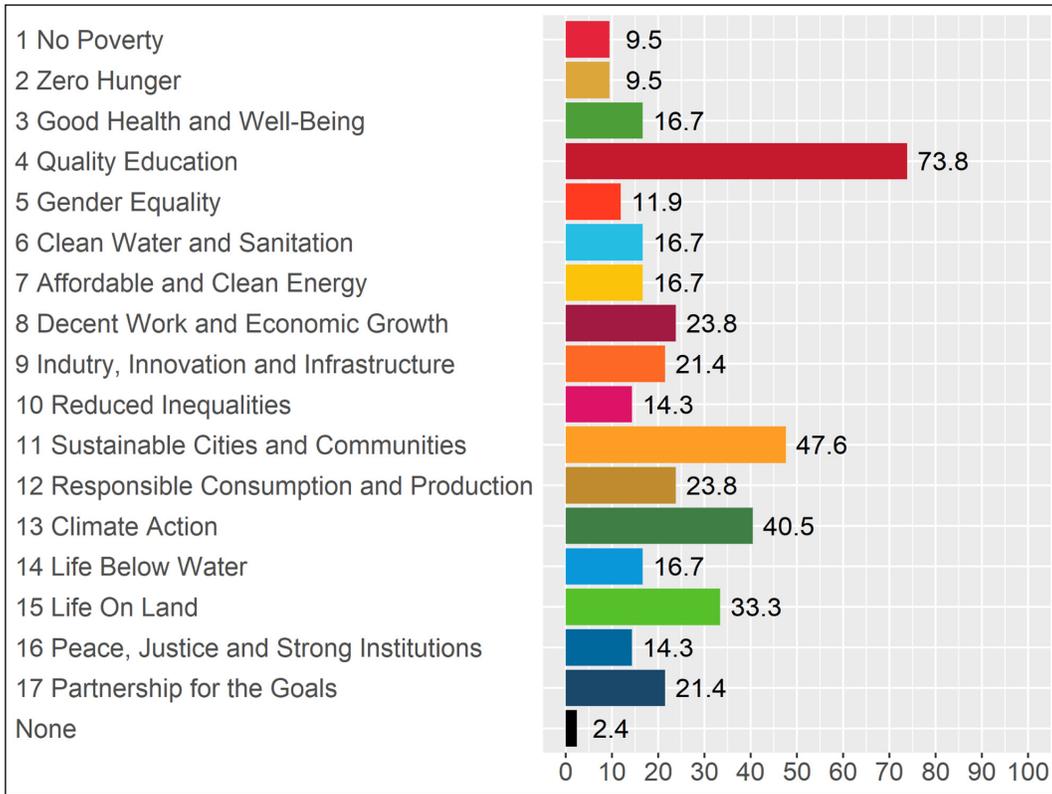


Figure 1 Survey Forum Citizen Science—self-assessed contribution of participants' research to the SDGs in percent (multiple answers possible, N = 42).

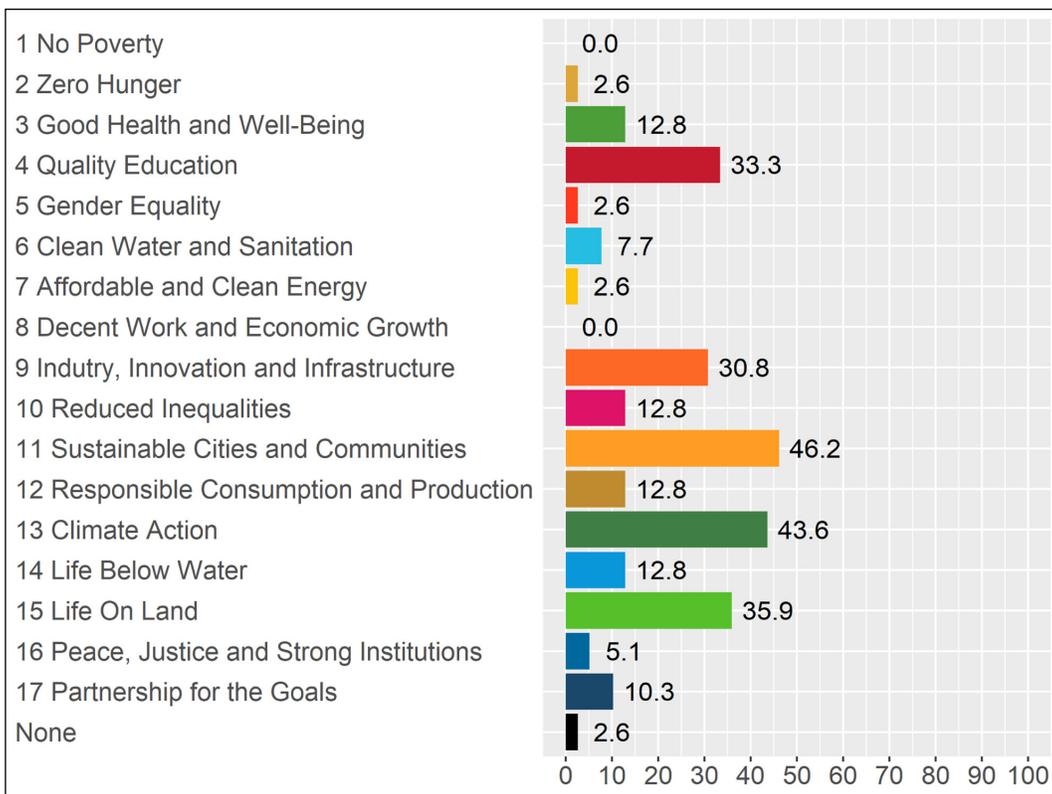


Figure 2 Survey German Citizen Science Platform—self-assessed contribution of participants' research to the SDGs in percent (Multiple answers possible, N = 39).

conference survey, and 46.2%, 43.6%, 35.9%, respectively, in the platform survey. Overall, apart from the strongly divergent vote for SDG 4, Quality Education, the selection behavior of the two surveys was very similar.

Notable differences at the level of the individual SDGs can be observed concerning SDG 8, Decent Work and Economic Growth (conference: 23.8% versus platform: 0.0%), and SDG 9, Industry, Innovation, and Infrastructure (conference: 21.4% versus platform: 30.8%) (Figures 1 and 2). The latter observation is noteworthy not solely because of the large percentage difference. It stands out primarily because it was one of only three SDGs, along with SDG 13, Climate Action, and SDG 15, Life on Land, that accounted for more percentage points in the platform survey.

In terms of key trends, it became evident that despite roughly equal sample sizes (conference: n = 42, platform: n = 39), conference survey respondents indicated more SDGs in total, at 176, than those in the project coordinator survey, at 105. Logically, this results in different mean scores for the two samples. In the conference survey, a mean of 4.2 SDGs was indicated, compared with only 2.7 SDGs in the survey of project coordinators.

INTERSECTIONS OF RESEARCH AND SUSTAINABLE DEVELOPMENT GOALS

Figures 3 and 4 show how respondents to the two surveys viewed the impact of the SDGs on their research and sustainability research in general. The first question aimed

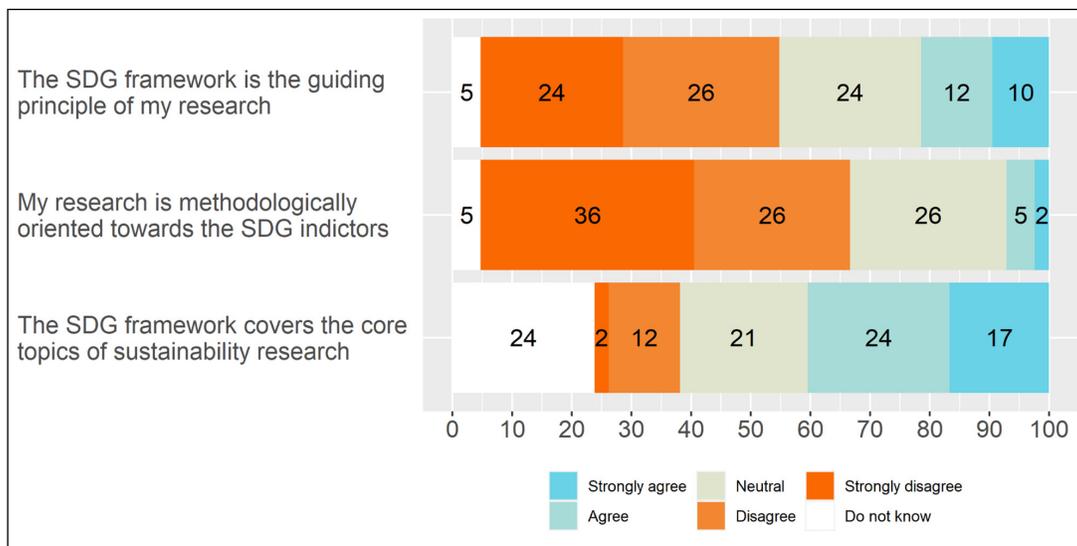


Figure 3 Survey Forum Citizen Science—assessment of intersections of research and Sustainable Development Goals in percent (5-Point Likert Scale, N = 42).

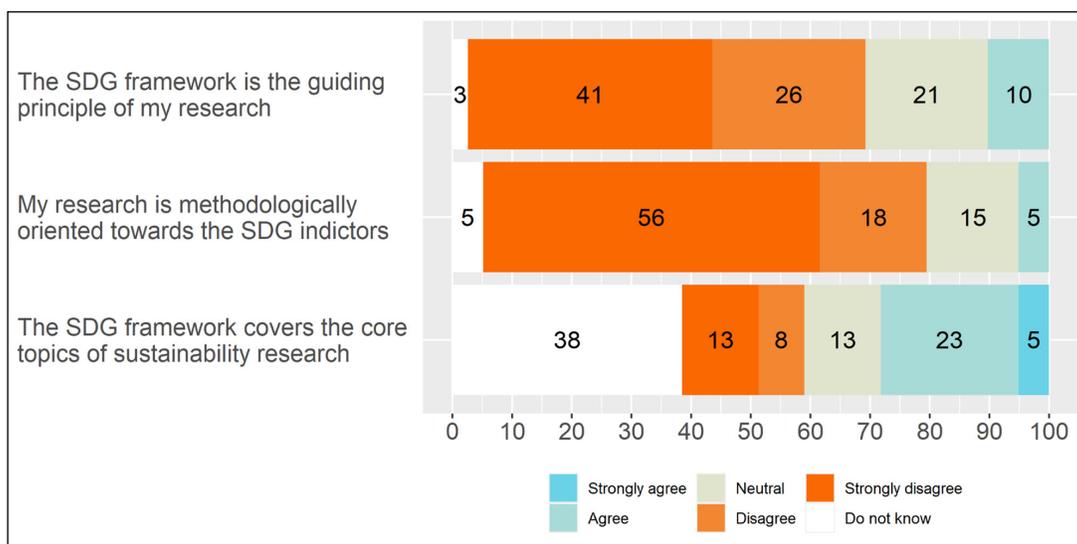


Figure 4 Survey German citizen science platform—assessment of intersections of research and Sustainable Development Goals in percent (5-Point Likert Scale, N = 39).

to gauge the impact that the SDG framework as a whole has on participants’ research. The second question related to the influence of the SDG indicators on the design of participants’ research. The third question asked for an assessment of the intersections between the SDG framework and current sustainability research.

Only 7% of respondents in the conference survey and 5% in the platform survey agreed with the statement that their research is methodologically oriented towards the SDG indicators. In the conference survey and platform survey, 26% and 15% of the participants, respectively, answered neutrally. The majority of participants, 62% in the conference survey and 74% in the platform survey, stated that the SDG indicators did not influence the methodology they used in their research. In both surveys, 5% of the respondents stated they could not assess this.

Attitudes towards the SDG framework in general were more positive overall. In the conference survey, 41% of respondents agreed with the statement that the SDG framework covers the main areas of sustainability research, compared with 28% in the platform survey. The proportion of neutral responses is 21% in the conference survey and 13% in the platform survey. 14% of the participants in the conference survey and 21% in the platform survey answered in the negative. Compared with the two previous questions, the proportion of “do not know” is significantly higher; 24% of the conference survey respondents and 38% of the platform survey participants did not feel able to answer the question adequately.

The percentage of (potential) project coordinators who confirmed that the SDG framework has an impact on their research ranged from 4% to 22%, depending on the question and participant group, with a higher rate of affirmative

responses among conference survey participants. The majority of responses from conference survey participants were, however, either neutral or negative. This response pattern was even more pronounced among participants in the platform survey. Attitudes towards the SDG framework in general and its synergies with sustainability research, which were addressed in the third question, were more positive in comparison, reaching a maximum level of 41% agreement in the conference survey. Moreover, participants in the conference survey tended to answer these questions more positively than respondents from the platform group. Overall, however, our data shows that only a few CS practitioners are implementing the SDG agenda in their research, especially at the level of the SDG indicators.

SYNERGIES BETWEEN CITIZEN SCIENCE AND THE SUSTAINABLE DEVELOPMENT GOALS

Figures 5 and 6 show how respondents of the two surveys perceived the synergies between CS and SDGs in general. First, respondents were asked to assess to what extent the SDGs provide an impetus for the design of CS projects. The second question sought to learn more about the influence of SDG indicators on participation formats in CS projects, while the third question explored the thematic overlap between CS sustainability engagement and the SDGs.

Responses to question 1 were mostly either positive or neutral in the conference survey. 33% of conference survey respondents indicated that they see the SDGs as a key driver for CS project design. 29% gave a neutral response. Only slightly more than a quarter (26%) believed that the SDGs have a minor impact on the design of CS projects. 12% of the respondents in the conference said they could not judge this. In the platform survey, more than twice as many

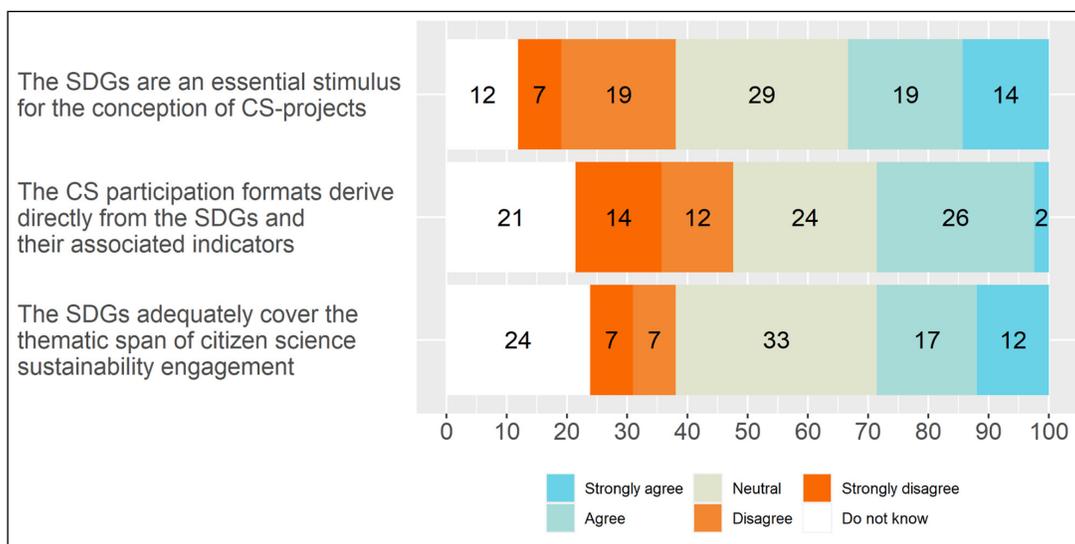


Figure 5 Survey Forum Citizen Science—assessment of synergies between citizen science and Sustainable Development Goals in percent (5-Point Likert Scale, N = 42).

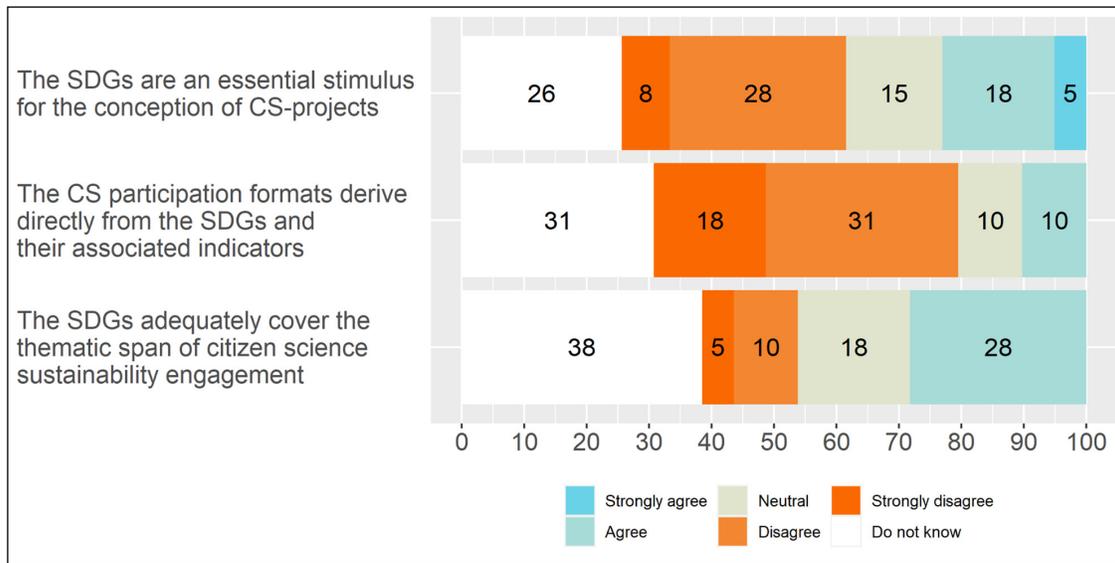


Figure 6 Survey German citizen science platform—assessment of synergies between citizen science and Sustainable Development Goals in percent (5-Point Likert Scale, N = 39).

participants (26%) felt unable to answer this question. In addition, the proportion of negative responses (36%) was also higher in the platform survey, which logically led to a smaller share of neutral (15%) and affirmative (23%) responses.

The response behavior concerning question 2 differed notably from the results just described. Compared with question 1, the number of affirmative responses was slightly lower (28%) and the number of negative responses slightly higher (14% strongly disagree) among participants in the conference survey. Moreover, a larger share of participants (21%) chose “do not know.” Overall, however, responses in the conference group were still significantly more positive than in the platform survey. Only 10% of the platform respondents confirmed that participation formats in CS projects are informed by the SDG indicators. Almost half (49%) of the participants disagreed with this statement, whereas 10% opted for a neutral response. It is furthermore striking that nearly a third (31%) of platform participants stated that they were unable to answer this question. Significant differences thus emerge in the survey participants’ assessment of the influence of the SDG indicators on participation formats in citizen science.

For question 3, the differences in response behavior between conference and platform surveys were overall less pronounced. The agreement scores for the statement that the SDGs adequately cover CS sustainability engagement topics were 29% for the conference survey and 28% for the platform survey, with a significantly larger proportion (12% versus 0%) of participants strongly agreeing in the conference survey. By contrast, large differences were evident concerning the share of neutral

responses. In the conference survey, 33% of participants expressed a neutral opinion, compared with only 18% in the platform survey. With roughly equal disapproval voting values (14% in the conference survey versus 15% in the platform survey), differences in response behavior were also reflected in the higher proportion of “do not know” answers in the platform survey (38%, versus 24% in the conference survey).

DISCUSSION

Our study was conducted in light of several publications showing that there is considerable untapped potential when it comes to CS-based contributions to the SDGs (Fraisl et al. 2020; Proden and Imaraliev 2021; Lepenies and Zakari 2021), and that as a result, current implementation of the SDG framework in CS practice falls short of the expectations expressed in the theoretical literature (West and Pateman 2017; Sauermann et al. 2020; Shulla et al. 2020). However, knowledge about why CS’s contribution to the SDGs has remained below its potential is sparse. We argue here that this is the case primarily because evidence on CS practitioners’ assessment of the SDG framework is still severely underrepresented in the existing literature, although it has already been highlighted as a desideratum (Fritz et al. 2019). To address this research gap, we took a novel approach to research on the synergies of CS and the SDGs and conducted two online surveys of German CS practitioners. Our aim was to explore a possible link between the CS community’s views on the SDG framework and the currently limited engagement of CS projects with the SDGs.

The data sets analyzed in this paper were well suited to providing an overview of the spectrum of opinions of CS practitioners in Germany in two respects: First, the pooled data set of the two surveys was large enough to be considered representative of the project database of the central German CS platform *Bürger schaffen Wissen*. At the time of the surveys, just over 200 projects were registered on this platform. Of course, it is possible that not all German CS projects at the time were listed on *Bürger schaffen Wissen*. But the fact that *Bürger schaffen Wissen* has been the central hub of the German CS community since 2014, funded by the German Federal Ministry of Education and Research, gives us reason to believe that these 200 projects adequately reflect the full range of CS activities in Germany. Second, the collection of two independent samples allowed for the investigation of divergences in response behavior resulting from possible differences in the research foci of the two groups of respondents.

In both of our surveys the participants mentioned SDG 4, Quality Education; SDG 11, Sustainable Cities and Communities; SDG 13, Climate Action, and SDG 15, Life on Land most frequently. These results on CS-practitioners self-assessment regarding their contribution to the SDGs are largely consistent with the findings of Moczek et al. (2021). The same applies to the study by Schleicher and Schmidt (2020), who conducted a peer assessment for German CS projects based on a qualitative content analysis. Respondents to the conference survey indicated, on average, a greater number of SDGs to which their project contributes, which was to be expected given the setting of the conference survey (an SDG conference). It is noteworthy, however, that only a very small proportion of respondents in both of our surveys indicated that their project did not contribute to any SDG at all. This contrasts with the assessment of the participants in both surveys on the synergies between CS and the SDG framework, which suggests that CS support for the SDGs in Germany is very limited.

Based on the results of our surveys, it seems that the SDGs are not yet fully mainstreamed among project coordinators in the German CS landscape and are only beginning to be incorporated into their research processes. The high proportion of negative or neutral responses in both surveys to the question of whether the SDGs have any impact on participants' research substantiates Lepenies and Zakari's (2021) assumption of low motivation among CS practitioners in Germany to actively contribute to the SDGs, and thus provides insights into why the actual quantifiable contribution of CS to the SDGs is still low in practice (Frais et al. 2020; Proden and Imaralieva 2021). The survey participants' responses to questions concerning the influence of the SDG framework on the methodological design of their research underline this argument: According to them, the SDGs

exert only a minor influence on the design of currently ongoing research projects. Only a few respondents in our survey considered the SDG indicators when choosing a methodology for their studies—which, of course, makes it very challenging for their research to later contribute data to SDG monitoring. This lack of consideration of SDG indicators at the planning stage, combined with insufficient support from NSOs (Bishop et al. 2020; Lepenies and Zakari 2021), may be one of the underlying reasons why CS practitioners in previous studies have named data sharing as one of their biggest challenges (Moczek et al. 2021; Sprinks et al. 2021).

We believe that two aspects are particularly striking with regard to the survey respondents' assessments of the questions about the intersections between the SDGs and sustainability research, the influence of the SDGs on CS project design and forms of participation, and the thematic overlap of the SDGs and citizen science sustainability agendas. First, the surprisingly high proportion of the answer option "do not know" to these questions indicates that some participants (depending on the question and group, the percentages vary between 10% and 30%) are not sufficiently familiar with the SDG framework and therefore tend to have a rather defensive response behavior. Alternatively, this could be because participants do not want to make a judgment about the entire field of sustainability research or the CS landscape as a whole. However, we suspect that this defensive response behavior suggests that CS practitioners in Germany do not know the SDG framework in detail. We find support for this assumption in the fact that SDG 4, Quality Education, is one of the SDGs most frequently mentioned in response to the question to which SDG the project or research contributes. Quality Education may at first glance seem like a reasonable or even obvious choice in the context of citizen science. But since all the indicators for this goal relate either to very basic educational achievements (such as literacy and numeracy rates) or to formal education (school completion rate, teachers' qualifications, availability of scholarships, etc.), it is in practice actually rather unsuitable for contributions from CS projects. Second, it is also remarkable that the responses differ substantially depending on whether participants were asked about the impact of the SDGs on their concrete research or more generally about the intersections of the SDGs with sustainability research or citizen science sustainability engagement. While questions concerning the direct influence of the SDG framework on the participants' research on average received the most negative responses, the respondents' assessments of the general synergies between sustainability research and CS sustainability engagement were more positive. We interpret these results as an indication that CS practitioners do not reject the SDG framework in its entirety. Rather, this is in

line with our review of the current literature, which showed that the synergies between SDGs and CS are quite plausible in theory (West and Pateman 2017; Sauermann et al. 2020; Shulla et al. 2020) but hardly adopted in practice by the CS practitioners (Fraisl et al. 2020; Proden and Imaralieva 2021; Lepenies and Zakari 2021). When they are not referring to their own research, respondents appear to be more optimistic about the synergies between CS and the SDG framework. However, we would like to emphasize that the high proportion of “do not know” in both samples limits the robustness of this observation.

The results of our novel approach of comparing response behavior in two different surveys support the finding that the SDGs are not yet fully mainstreamed among project coordinators in the German CS landscape and are only gradually being incorporated into their research processes. Not only were the responses in both data sets predominantly neutral to negative, but there are also differences in response behavior between the two samples. Therefore, our study provides new insights that suggest that there is one group within the German CS landscape that is more open to or interested in the SDG framework than the other. Not surprisingly, this is the group that participated in the Forum Citizen Science 2022, whose overarching theme was “Global—Regional—Local: CS for the SDGs”. For a survey conducted in the context of a CS-SDG conference in 2022, it is, however, indeed remarkable that the overall approval ratings are comparatively low. After all, seven years have passed since the declaration of the SDGs in 2015, and it can furthermore be assumed that most of the participants of the conference and the subsequent survey have their focus on sustainability research. The responses given by project coordinators from the German CS platform *Bürger schaffen Wissen* suggest that the SDGs are guiding research to an even lesser degree across the full spectrum of the CS landscape. We conclude that “CS for the SDGs” is at present still a niche phenomenon within the already small niche of CS when compared with the German research landscape as a whole. In other words: It is a niche within a niche. In our opinion, it is likely that this statement can be generalized to other European countries, such as Austria, Switzerland, and Spain, with comparable CS infrastructures (e.g., a national CS platform, CS funding by ministries and foundations, CS professorships or master courses). In fact, since CS in Germany already has more established structures than some other (European) countries, the results of comparable studies in other countries could be even more negative. A similar survey conducted in a different setting, especially in developing and emerging countries where CS plays a larger role in SDG reporting owing to the lack of established NSO structures, might, however, yield different results (Fritz et al. 2019, de Sherbinin et al. 2021).

Individual reasons for the low impact of the SDGs on respondents’ research were not the subject of our survey and are therefore difficult to assess based on our comparatively basic set of questions. Moreover, the relationship between CS and the SDGs is also shaped by several structural factors that lie beyond the scope of this study, such as political and institutional support, available funding, etc. Yet, the results of our study do allow us to infer two possible reasons for the currently low level of CS engagement with the SDGs (Fraisl et al. 2020; Proden and Imaralieva 2021; Lepenies and Zakari 2021). The first is a lack of knowledge on the part of CS practitioners. As pointed out earlier, the high rate of “do not know” answers throughout the surveys suggest that, even among those participants who had just attended a conference dedicated to the topic, many were not truly familiar with the SDG framework. A second possible explanation for the current state of affairs is a perceived lack of relevance. The predominantly negative or neutral responses to questions about the impact of the SDGs on the thematic focus and methodological design of their research indicate that a significant number of participants do not see a connection between the SDG targets or indicators and their own work. This conceptual and methodological disconnect between the SDG framework and reality on the ground (i.e., the actual research being done by CS practitioners) is perhaps not surprising, given that the latter is still primarily geared towards NSOs.

CONCLUSION

The results discussed above show that only a small proportion of German CS practitioners align their research with the SDG framework. Our data suggest that this can be attributed to a lack of familiarity with the SDG framework. In light of these findings, we conclude by offering a succinct assessment of what measures could be taken to encourage citizen science practitioners to contribute to the SDGs through their projects. On the one hand, the high percentage of “do not know” answers suggests that it may be essential to further educate CS practitioners about the SDGs by employing needs-based training. Importantly, this training should take into consideration not just the collection of monitoring data but all the channels of potential contributions identified in the literature (West and Pateman 2017; Sauermann et al. 2020; Shulla et al. 2020) to provide concrete guidance on how projects can support the SDGs at the goal, target, or indicator level. On the other hand, we see the predominantly negative responses regarding the impact of the SDGs on participants’ research as a call to flexibilize the rigid structure of the SDG framework. Currently, the SDG framework is primarily tailored to statistical agencies, but as

research has repeatedly shown, they are no longer the only data collectors. We believe that opening up the SDGs to input from the CS community would help bring the framework into closer alignment with the research methods, competences, and aims of CS projects. We are convinced that greater involvement of CS practitioners in a potential adaptation of the SDG framework could lay the foundation for a more active engagement of CS practitioners and projects with the SDGs. The combination of both—low-threshold SDG training opportunities and possibilities for stronger participation in the future evolution of the SDG framework—could be an effective way to increase the contribution of CS projects to the SDGs in the medium term and bring “CS for the SDGs” out of its niche.

DATA ACCESSIBILITY STATEMENT

The data analyzed in this paper are available upon request. Please contact the first author for access.

ETHICS AND CONSENT

Ethical review and approval were not required for this study, as we worked closely with the data protection officer to provide all participants with detailed information about the conditions. Only after they had consented to these they could participate in the surveys. Specifically, we informed that participation was voluntary, questions could be skipped, and participation in the study could be terminated at any time and information already stored could be completely deleted. All responses were anonymous. Publication of the results does not allow any conclusions to be drawn about the project or the individual. The data was stored in a database of the Museum für Naturkunde exclusively for research purposes. The survey software SoSciSurvey was developed and is operated by a German company. The server is located in Munich. All privacy settings were set restrictively.

COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

This paper was designed jointly by all authors. The first, second, and fifth authors designed the survey. The first author analyzed the data, wrote the first draft of the manuscript, and revised it with the third and fifth authors.

The final version of the manuscript was approved by the other two authors.

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