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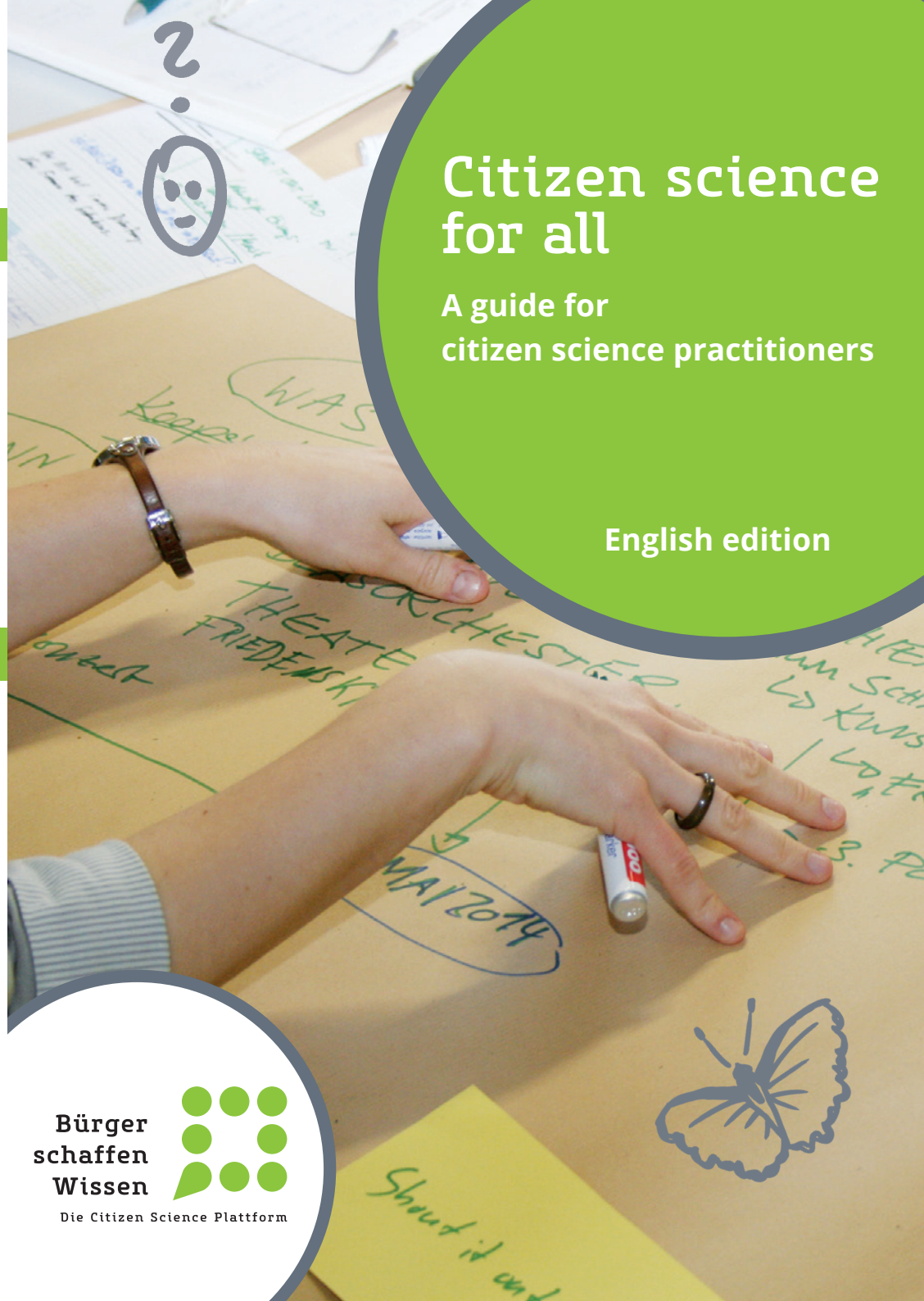

Citizen science for all

A guide for citizen science practitioners

English edition

Bürger schaffen Wissen
Die Citizen Science Plattform

Citizen science for all

A guide for citizen science practitioners

by
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GEWISS Programme

Citizens Create Knowledge – Knowledge Creates Citizens (BürGEr schaffen WISSen – Wissen schafft Bürger, GEWISS) is a capacity-building programme aimed at strengthening citizen science in Germany. The consortium project is led by institutes of the Helmholtz and the Leibniz Association with their university partners. Participating partner institutions are: the German Centre for integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig together with the Helmholtz Centre for Environmental Research (UFZ) and the Friedrich Schiller University Jena; in collaboration with the Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB) together with the Museum für Naturkunde – Leibniz Institute for Evolution and Biodiversity Science (MfN), the Leibniz Institute for Freshwater Ecology and Inland Fisheries (IGB), the Leibniz Institute for Zoo and Wildlife Research (IZW) and the Freie Universität Berlin. The Leibniz Research Alliance Biodiversity (LVB) and Wissenschaft im Dialog (WiD) are also proect partners. For more information, please go to **www.buergerschaffenwissen.de/en**.

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Disclaimer

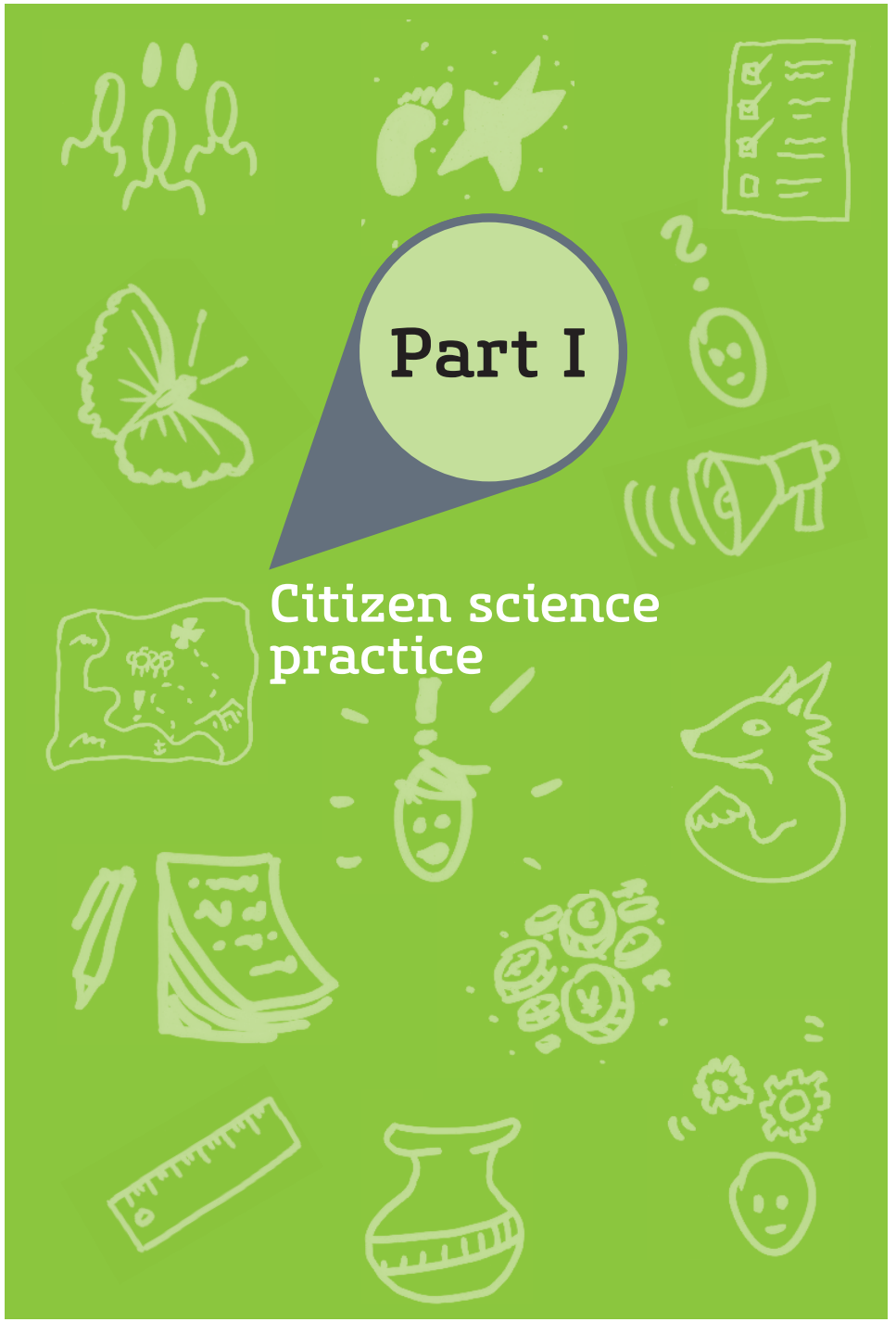
Foreword

Citizen science is a topic that is gaining attention and relevance both among practitioners and in the media. This guide describes how citizen science is practiced in Germany (Part 1: **Citizen science practice**) and how this participatory approach can be used in different research disciplines and issue areas – such as education, conservation or the arts and humanities (Part 2: **Citizen science landscape**). This guide is primarily intended for those initiating citizen science projects, but also for anyone participating in such projects. This includes scientists working in research institutions who would like to collaborate with citizens, as well as individuals and society-based groups such as independent scientific groups, associations or other NGOs.

This guide is the result of intense collaboration between a wide range of stakeholders in the citizen science community within the Citizens Create Knowledge (BürGEr schaffen WISSen, GEWISS) project. It is based on insights gained at our dialogue forums and other events. Some stories about projects were contributed from participants in our storytelling workshop and a storytelling session at the Citizen Science Forum in March 2016.

Citizen science will develop further and continue to diversify in the years ahead. We will more clearly define quality criteria and better understand how to realise citizen science projects and research with citizen science components that generate positive results for science and society. We hope to aid these efforts with our Citizen Science Wiki (**wiki.buergerschaffenwissen.de**, currently only in German). The wiki provides in-depth information on subjects that can only be touched upon here. Happy reading!

In the name of the entire GEWISS team,
Katrin Vohland and Aletta Bonn


Part I
Citizen science practice

1 What is citizen science?

This term describes an approach [2][1] where scientific insight is gained by individuals who do not work professionally in the relevant scientific field, with or without the support of professional researchers. In the dialogue process set in motion by the Citizens Create Knowledge (GEWISS) project, more than 700 individuals from over 350 organisations and a wide range of citizen science activities discussed this complex topic, resulting in the following definition of citizen science:

> Citizen science describes the engagement of people in scientific processes who are not tied to institutions in that field of science. Participation can range from the short-term collection of data to the intensive use of leisure time in order to delve deeper into a research topic together with scientists and/or other volunteers. Although many volunteer scientists do have a university degree, this is not a prerequisite for participating in research projects. However, it is important that scientific standards are adhered to. This pertains especially to transparency with regard to the data collection methodology and the open discussion of the results. [1], p. 13

Some citizen science is initiated by institutional scientists – giving citizens the opportunity to observe, for example, environmental phenomena or to analyse large datasets online. Citizen science projects are also increasingly launched by government agencies or practiced in schools. However, citizen science can also mean independent individual commitment as a volunteer, for example in independent scientific groups (Fachgesellschaften) that meet regularly on scientific topics such as amphibians or regional history, sharing information and generating new knowledge. There are also citizen science projects initiated by citizens or organised civil society who hope to use problem-focused research to transform their environment, who may involve professional scientists at different times [20].

1 All sources are cited alphabetically in the resource list and are referred to by number in the text.

All of these activities create scientific knowledge outside institutionalised science that can be fed back into the scientific community. In addition, citizen science seeks to strengthen exchange, increase access to knowledge and build common cause between science and society. This also includes open access and open science methods and the dissemination of research results to the public.

Terms such as public or civic science and amateur research are sometimes synonymous with citizen science, and terms such as do-it-yourself or DIY science, public history and transdisciplinary research share some of the characteristics of citizen science. In order to facilitate understanding including internationally, we stick to the term citizen science and use it in a wider sense to cover a wide, diverse range of activities.

Further resources

- ScienceCité hosts a Swiss platform on 'dialogue science': **www.science-et-cite.ch/en/projects/**
- The Austrian citizen science platform has many projects and further resources: **www.citizen-science.at** (GER)[2]
- The Austrian research ministry funds many citizen science projects, especially in schools: **www.sparklingscience.at/en**
- The Citizen Science Association in the USA has a variety of resources: **www.citizenscienceassociation.org**
- The German citizen science platform offers examples of projects and further information on citizen science: **www.buergerschaffenwissen.de/en**

2 Because this guide was originally written for a German-speaking audience, many of the resources here are only available in German. When possible, we provide English-language resources in this translation; those in German language are marked with '(GER)'.

2 Why citizen science? What are the advantages? What are the challenges?

Citizen science is an approach that allows public participation in science, which has many advantages [6]. It is often claimed that, depending on the nature of the project and participation, the following benefits can be achieved:

Benefits for Science	Benefits for Society	Benefits for Participants
• Inspires new research topics by inviting new ideas, questions, methods, and societal knowledge • Creates large datasets (spatially and temporally) that can be adapted to various uses • Allows diverse evaluation capacities including photos, scans and video sequences • Increases public acceptance of research results • Promotes public evaluation of research • Verifies the practical relevance and applicability of scientific results	• Generates and communicates socially relevant research topics • Allows co-creation of transparent research • Allows society to take on responsibility for research • Introduces all participants to new perspectives • Develops opportunities for societal transformation, e.g. towards sustainability • Promotes better transfer of research results into practice through early involvement of societal actors • Democratizes the discursive meaning of science • Strengthens civil society and government agencies	• Allows contributions to scientific discoveries • Improves understanding of science and sometimes advances scientific qualifications • Increases understanding of complex problems • Introduces innovative ideas into science • Facilitates participation in political decision-making through scientific contributions • Contributes ideas and suggestions for alternatives • Allows critical examination of scientific results • Promotes a better environment and a better society • Is fun and promotes sharing

Not all of these benefits have yet been realised, and it would be impossible to achieve all of these potential goals in a single project. This makes it even more important to think carefully about what goals are to be achieved in a planned project.

Citizen science is just one of many ways to include citizens in research. It may not be suitable or practical for all scientific purposes and may not always make sense for the research issues at hand. It is important as a project initiator to consider during project conception whether citizen science is the best approach. Before starting a project, the following questions should be addressed:

- Topic suitability: Who, apart from the research team, would be interested in the topic?
- Method suitability: Are the methods well suited to answering the question and compatible with citizen science?
- Special knowledge requirements: What do researchers and participants need to know and will they be able to learn this in the course of the project?
- Extra time requirements: What extra time is necessary for communication, coordination and training, including implementation of data protocols or use of apps? Are the required resources available?
- Equipment and infrastructure requirements: What resources and infrastructure are required? Are they available?
- Long-term commitment: What will happen when the project ends? How can collaborative relationships, new infrastructures and scientific results be used after the project is over?
- Legal and ethical requirements: Are there legal or ethical guidelines that need to be considered?
- Project evaluation: Who is responsible or interested in evaluating the project? What are the criteria for evaluation?

STORY

Integrating ceramics experts into an experimental archaeology project

Pottery production in the Antiquity and Middle Ages may have reached industrial scale. However, there are no reliable figures on kiln productivity and capacity. Such data would be necessary to make robust statements on the decline or survival of pottery over centuries. The Lab for Experimental Archaeology at the Romano-Germanic Central Museum (RGZM) has reconstructed working kilns of large Mayen potteries.

From the beginning, a small group of ceramics experts with experience in areas such as development aid, schools, vocational training and living history were involved in the project. For all, involvement in the project opens up opportunities for their professional training and personal education.

The technical requirements, the time commitment and personal objectives were discussed with each individual and communicated within the research group. It was important to understand that the individuals involved were not an unlimited human resource and that they should expect some benefit for themselves. It is also important to clarify the commitments that arise from the institutional setting. Although these are less exciting, they are important to understand for the project to run smoothly. In addition, knowledge of administrative issues helps ceramics experts act as the face of the institution when dealing with the public. The project has been largely successful in encouraging participants to represent the museum using their own words.

3 Initiating a citizen science project – choosing partners, methods and participants

Who can initiate a citizen science project? Anybody! All that is required is (at least) one person with an idea, a certain interest in research and enough motivation to promote the idea. This individual or group of individuals may be working as a scientist or be involved in civil society, working alone or as part of a larger team. The only prerequisite is that the idea has some scientific value.

The following points must be considered when planning a large project:

- Roles and responsibilities: Who should participate in the project and how? What part do participants play and who is responsible for what activities? Having clearly defined roles makes the project transparent.
- Clearly defined goals: What do you want to achieve with this project? It is important to define clear and concrete goals together with all participants at the beginning of the project. Having clear goals makes evaluation easier.
- Forms of participation: How many people should be involved, and how can they contribute to the project? What kind of commitment is required? Is equipment or training needed for initiators or participants?
- Clear research question: Careful consideration on the research objective in early stages prevents collection of unnecessary or unusable data.
- Legal requirements: What legal requirements for data protection, communication and the involvement of individuals or groups of individuals should be considered? Potential legal issues vary by jurisdiction and need to be clarified with a legal expert.
- Choice of methods: How will the data be collected, evaluated and published?
- Evaluation: What types of objectives should be reached and how should they be measured?

Tip: Methods

The choice of methods depends on the discipline and the research topic, as in all scientific research. A monitoring project, for example (e.g. **Butterfly Monitoring Germany**, p. 15) requires a standardised design for data collection and data storage, whereas evaluation algorithms and data infrastructures are the main concern in digital crowdsourcing projects (e.g. **ARTigo**, p. 36) . In any case, it is important to clearly describe the methods used.

BeachExplorer – an international project from the start **STORY**

The idea of establishing a portal to record all beach findings in the Wadden Sea was born in winter 2006 at a meeting of the Wadden Sea education centres. The participating rangers from Denmark, Germany and the Netherlands compared notes on whale beachings and realised that there seemed to be no information exchange across borders. The idea of a trilateral Internet portal, where beached items and animals could be recorded, developed from there. The Wadden Sea Conservation Station took over the task of fundraising to put it into practice.

www.beachexplorer.org

Further resources

- Further guidelines for initiating citizen science projects can be found at: **www.citizen-science.at/citizen-science/wegweiser** (GER)
- The Centre for Ecology & Hydrology offers a best practice guide: **www.ceh.ac.uk/citizen-science-best-practice-guide**
- The Dialogic Change Model is a good resource for ensuring effective collaboration between diverse stakeholders: **www.stakeholderdialogues.net**

4 Data: Important issues for citizen science data

Citizen science projects often deal with large datasets, whether they are monitoring projects (**Butterfly Monitoring Germany**, p. 15), crowdsourcing projects (**ARTigo**, p. 36) or observational studies (**Landscape Change**, p. 32). It is important to decide before the start of a project which data can be collected, who should have which rights relating to the data and how they can be secured and made available in the long-term. Data management must be transparent at all times and comply with legal requirements. Data should be stored and managed in permanent infrastructures with availability and clarity in mind. This includes metadata (such as time, method or location of collected data). Sometimes, it is impossible to further use data without such information.

Legal framework

The following legal categories are important in connection with citizen science: copyright (especially for images/photos, text, video and audio) including the so-called 'freedom of panorama' related to property lines, sui generis database rights, freedom of information, federal and state legislation on data protection with provisions for personal data (in particular the right of informational self-determination), legislation relating to inspection of records (in particular passing on citizen science data to institutions with a statutory obligation to publish information), breach of the duty of care (e.g. in forum contributions) as well as the application of telecommunications and media legislation. Depending on the field of research, additional legislation may apply, (e.g. the Environmental Information Act or Nature Conservation Act). In addition, ethical questions such as the collection of participants' health-related data, must be considered and, where applicable, discussed in an ethics committee.

Data quality

Data quality includes validity in terms of how data reflect reality and whether they provide an answer to the research question **[14]**. A solid research design, based on a clearly formulated research question, is crucial. In practice, however, not every citizen science project begins with a clearly defined research question or is focused on data quality. Other objectives may be more important, such as scientific education or empowerment of participants.

In order to ensure scientific benefits, data quality and data protection issues must be addressed right from the start.

There are several ways to guarantee that good data are produced, included volunteer training, distribution of guidelines or manuals and development of other teaching materials. It may be critical to engage a sufficiently large number of data collectors in order to ensure that the data have sufficient resolution, both temporally and spatially. It may be beneficial to design data input protocols or data collection software that restricts data inputs (e.g. date, yes/no, numbers and pre-designed drop-down menus) in order to reduce excessive free text and resulting errors.

After data are entered, implementation of a consistency check can alert collectors of implausible or possibly faulty data and further improve data quality. Communication and feedback are important in the data revision process. Such downstream quality assurance is often carried out by experts, but mutual checks can also be carried out by all participants or automated programmes (e.g. to check for statistical outliers) [12].

Data availability and accessibility

Digital storage of data in databases is usually required in order to further use the data. Long-term data protection and storage, however, is a challenge, as storage media are constantly changing. It can be beneficial to connect larger databases to the IT infrastructure of organisations that have repositories to store and manage data for long periods of time. An overview of such repositories can be found at **www.re3data.org**.

However, availability does not necessarily guarantee that the data are usable. They must also be accessible, which means well documented and easy to interpret. Here, the use of recognised metadata standards can ensure that data with diverse structures and formats can be described in a way that ensures their long-term accessibility – and usability.

STORY

Transect mapping in Butterfly Monitoring Germany

In order to generate sufficient data on the development of common butterflies, researchers rely on the help of many volunteers. Luckily, butterflies are very popular thanks to their beauty and many naturalists are happy to give their time if it helps to protect these fascinating creatures. Citizen scientists come in all sizes and shapes: amateurs and entomologists, school children and pensioners. 'Taking a stroll for science' is the call heard by roughly 500 people who have participated in Butterfly Monitoring Germany.

In order to evaluate the data in a scientifically sound manner, it is important that they follow a common standard. A standard using line transect mapping was developed by Britain and the Netherlands, where butterflies have been counted since the 1970s or 1990s. Each participant receives detailed instructions for counting and is helped to get up to speed. The data collected are then compared with other European countries.

www.tagfalter-monitoring.de

Tip

Data quality and protection are extremely complex issues. More information can be found on the Citizen Science Wiki: **wiki.buergerschaffenwissen.de/w/Kategorie:Datensammlung_und_-verarbeitung** (GER)

Further resources

- A German report on data issues in biodiversity citizen science: Wahl, J., Wiebe, A., Grescho, Krämer, R., Schwarz, J. & Wedekind, S. (2016). *Lebendiger Atlas – Natur Deutschland: Workshop Dateninfrastruktur, Datenmanagement und Datenrecht am 10./11. März 2016 in Göttingen*. Helmholtz Centre for Environmental Research (UFZ) and German Centre for integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig. Available online at: **www.ufz.de/lebendiger-atlas/** (GER)
- Results of a survey in Europe on the use of data by volunteers: **bookshop.europa.eu/en/survey-report-pbLBNA27920/**
- Information on the open licensing model Creative Commons: **www.creativecommons.org**
- More information on data issues in citizen science: Richter, A., Mahla, A., Tochtermann, K., Scholz, W., Zedlitz, J., Wurbs, A., Vohland, K. & Bonn, A. (2015). *GEWISS Dialogforum: Datenqualität, Datenmanagement und rechtliche Aspekte in Citizen Science*. Bericht Nr. 6. Helmholtz Centre for Environmental Research (UFZ), Leipzig; German Centre for integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB), Museum für Naturkunde (MfN) – Leibniz Institute for Evolution and Biodiversity Science, Berlin. Available online at **www.buergerschaffen wissen.de** (GER)

5 Communication and feedback

In coordinating collaborative work between different actors, it is critical to communicate well, both within the project and with the outside world. Communication can therefore take more time in citizen science than in other research projects. It is worth it to spend some thought on internal and external communication. Here, we summarise internal and external communication together, as they require similar considerations.

A communication strategy can be helpful and address the following points:

- Who are the main participants in the project? Who else is involved? Who communicates with whom? Are there specific coordinators for different working groups or tasks? Do researchers (both professional and volunteer) work independently or closely together?
- Who has the communication skills and resources to represent the project to the outside world? Can the team mobilise the support of professional science communicators (e.g. an organisation's press office or a journalist)?
- How is communication to take place? What channels are to be used, such as e-mail, workshops or regular meetings? Are there certain forms of communication or a special type of language, e.g. where teenagers or people with less formal education are involved? Are there best practice guides in the research area that could help to explain the topic to a wider audience?
- What information needs to be communicated and how often? Weekly newsletters for participants – or better monthly? Is there a helpdesk for participants to contact with questions? Does the project need a dedicated website and what functions and information should it have? Can social media reach selected target groups and how can people without Internet access be reached (e.g. through print media, radio and TV)?
- When and why should communication take place with which target groups? Is communication necessary to gain supporters or to raise funds? What exactly should be communicated and what should be left out?

How much needs to be invested in terms of time and personnel? This is often underestimated in citizen science projects.

Tip

Online tools have great potential for communication. A blog can be useful in keeping participants informed on the current stage of research. Wikis, etherpads and similar tools as well as instant messenger services (with appropriate data protection) can aid collaborative work. Offline tools can supplement digital approaches and reach people who do not have access to online media.

Citizens who freely commit their time and talents, whether to civil society or citizen science, rightly expect their efforts to be recognised. This includes giving feedback, which can take many forms. Existing projects can inspire or advise newer projects. Successful citizen science project communication means treating citizens, the media and other multipliers as equals. Here are some examples of how to promote good feedback:

- Collective publication of results (open access and in scientific journals)
- Links to national and international citizen science networks
- Naming participants in acknowledgements or as co-authors
- Sending newsletters with scientific results
- Organising events (talks, educational programmes, parties)
- Communication training for participants to share results

It is crucial in all communication efforts in a citizen science project to make it clear how the content of the project relates to citizens. What are they interested in, what makes them tick? Narratives (storytelling) may be helpful in communicating scientific content in a simple, but not simplistic, manner. Sometimes such tools have become all but indispensable in citizen science.

Press interviews and media partnerships can also be helpful in spreading news about the project and related activities. A good media partnership should find suitable interview candidates, prepare information about the project and provide suitable images. It is also important to identified a contact person for the press. Who can be press officer for what issues and who has a good media presence?

Tip

Generally, a project website is a first port of call for newcomers to a project. This means it should be clearly structured and easy to navigate. Answering the following questions can give you a head start when building your website: What is the project about? What people and institutions are involved? How can citizens participate? What will happen to the data collected? What are the benefits for participating? Who is the contact person?

Further resources

- Fundamentals of science communication: **www.aaas.org/page/communication-fundamentals-0**
- Guidelines on good public relations (PR) in science: **www.wissenschaft-im-dialog.de/trends-themen/blogartikel/beitrag/finale-version-der-leitlinien-zur-guten-wissenschafts-pr-veroeffentlicht/**
- How to carry out a usability test: **www2.bui.haw-hamburg.de/pers/ursula.schulz/webusability/quicktest.html**
- Information on storytelling methods: Pettibone, L., Grimm, M., und Ziegler, D. (2016): *Storytelling für Citizen Science: Tipps zur erfolgreichen Konzeption und Durchführung eines Storytelling-Workshops*. GEWISS-Trainingsbericht Nr. 1. Helmholtz Centre for Environmental Research (UFZ), Leipzig; German Centre for integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB), Museum für Naturkunde (MfN) – Leibniz Institute for Evolution and Biodiversity Science, Berlin. Available online at **www.buergerschaffenwissen.de** (GER)

STORY

Successful media cooperation – Foxes in the City

An increasing number of wild animals lives in the city. In addition to rabbits and wild boar, Berlin has many foxes. The project 'Foxes in the City' is run by a team of scientists at the Leibniz Institute for Zoo and Wildlife Research (IZW) to find out where and how foxes live in Berlin. The project uses not only traditional research methods such as recording movement patterns using GPS collars, but also asks citizens to take part. How do they learn about the project? The Berlin-Brandenburg public radio station (rbb) was an important supporter from the beginning. It acted as the interface between scientists and the public, sharing information and receiving fox siting reports and ideas from the public. Since spring 2015, the station has reported several times on the project on radio and TV. These efforts have reached about 320,000 viewers and listeners. Citizens can upload photos and videos and send in reports relating to the daily life of foxes in the city. Approximately 1,500 contributions have already been received and since June 2016 citizens have been able to participate in the progress of the project online on an interactive map of Berlin. **www.rbb-online.de/fuechse**

6 Evaluating citizen science projects

What makes a citizen science project a success? This sort of question is often asked as part of an evaluation process. It is important for both funding institutions [21] and organisers of citizen science projects [19] that projects meet certain quality criteria.

Still, evaluating citizen science projects poses its own challenges. Participants may have different objectives from project organisers or funders, which must be considered in the evaluation process. The types of goals pursued in existing citizen science projects often include:

- the project's scientific output
- how citizens are engaged in the research process
- educational outcomes, e.g. scientific literacy or environmental education
- increased awareness of socially relevant issues

In addition, citizen science projects must often fulfill additional requirements, such as:

- project transparency, including communicating various tasks, functions and roles in the project and the use of results
- data quality, security and privacy measures
- long-term outlook, sustainability of project outcomes and data management

In the end, participants must decide how they want to attain which objective levels. It is particularly important to communicate these objectives within and outside the project organisation. Typical steps in an evaluation process involve:

- Defining project objectives: This is best done at the beginning of the project and should important stakeholders and participants.
- Planning the evaluation: This include means clarifying the evaluation team, duration, depth, available resources, methodology, schedule and procedure (e.g. ex post or iterative evaluation). It is often helpful to evaluate a project according to criteria defined at the start of the project.
- Conducting the evaluation and analysing results
- Implementing results, potentially by adapting the project

Further resources

- Evaluation criteria for Austrian citizen science projects: Kieslinger, B., Schäfer, T., & Fabian, C. (2015). *Kriterienkatalog zur Bewertung von Citizen Science Projekten und Projektanträgen*. Im Auftrag des BMWFW. Available online at: **www.zsi.at/object/publication/3864/attach/Kieslinger_Schaefer_Fabian_CS_Kriterien_2015.pdf** (GER)
- General thoughts on citizen science evaluation: Ziegler, D., Brandt, M., & Vohland, K. (2015). Workshop: (Weiter)Entwicklung von Kriterien und Indikatoren für Citizen Science in der Forschung. In: Pettibone, L., Ziegler, D., Richter, A., Hecker, S., Bonn, A. & Vohland, K., Hrsg. *GEWISS Dialogforum: Forschungsförderung für Citizen Science*. GEWISS Bericht Nr. 7. Helmholtz Centre for Environmental Research (UFZ), Leipzig; German Centre for integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB), Museum für Naturkunde (MfN) – Leibniz Institute for Evolution and Biodiversity Science, Berlin. pp. 7–10. Available online at **www.buergerschaffenwissen.de** (GER)

7 Funding instruments

There are various options for funding a citizen science project. These include tailor-made citizen science funding programmes, such as the recently released call for bids *Richtlinie zur Förderung von bürgerwissenschaftlichen Vorhaben* (Citizen Science) by the German Federal Ministry of Education and Research (BMBF), and hybrid funding combining complementary elements from a wide range of programmes. In addition to project funding, individuals can be supported through measures such as training, taking part in workshops and being given access to infrastructure. Citizen science may also be funded in the context of other science policy initiatives, such as Responsible Research and Innovation (RRI). BMBF's budget for citizen involvement and the Preservation Nation initiative by the National Trust are other possibilities here. Here, funding decisions are made based on the project's or initiative's creativity and ability to foster innovation and creativity, regardless of issue area.

However, before searching databases for funding calls and relevant foundations, it is important to determine which parts of the project need funding. Is more staff needed to develop and manage the project, to collect data or for communication purposes? Is training required? Is more space needed? Does project infrastructure need additional resources, such as computers and lab equipment? A particular funding source may only covers specific aspects of a project's needs.

Funding options for citizen science projects

Existing funding for citizen science projects in Germany and internationally is very divers – there is a range of funding bodies. At the European level, numerous Horizon 2020 calls for project proposals that involve citizens directly or, more indirectly, help to develop methodology or social transformation. The German Federal Environmental Foundation (DBU) recently published new funding guidelines relating to citizen science projects. Other foundations support citizen science activities in specialised areas of research. Crowdfunding is also an option (e.g. through Science Starter).

Citizen science can also be funded through membership fees (e.g. **Casualty Lists in World War I**, p. 43). Other projected were kick-started by university funding (e.g. **KLEKs**). In many cases, federal and state governments, BMBF, the German Research

Foundation (DFG) or the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) can provide funding. Funding through lottery money, businesses and charities have not yet played a major role in the German-speaking world, with some exceptions: the Swiss project Flora at the Canton Zürich, **FLoZ**, is funded by lottery money (**www.floz.zbg.ch**). Cities and townships are additional potential funding sources.

How existing initiatives support citizen science

Citizen Science is increasingly seen as an important approach to knowledge transfer. By involving citizens in ways beyond traditional forms of science communication, it encourages innovation. Thus, citizen science is now mentioned within the framework of BMBF funding for sustainability research (FONA) and by the Austria's research ministry's (BMWFW) TOP Citizen Science programme.

Further resources

- Current areas receiving funding from the Deutsche Bundesstiftung Umwelt (DBU): **www.dbu.de/index.php?menuecms=2505**
- FONA, BMBF's programme for sustainability research: **www.fona.de**
- Horizon 2020, the EU Framework Programme for Research and Innovation: **ec.europa.eu/programmes/horizon2020/**
- Science Starter, a crowdfunding platform for scientific projects: **www.sciencestarter.de**
- TOP Citizen Science, run by the Austrian BMWFW, which also funds citizen science through Sparkling Science and FWF (Fonds zur Förderung der wissenschaftlichen Forschung) programmes **www.fwf.ac.at/de/forschungsfoerderung/fwf-programme/foerderinitiative-top-citizen-science/** (GER)

STORY

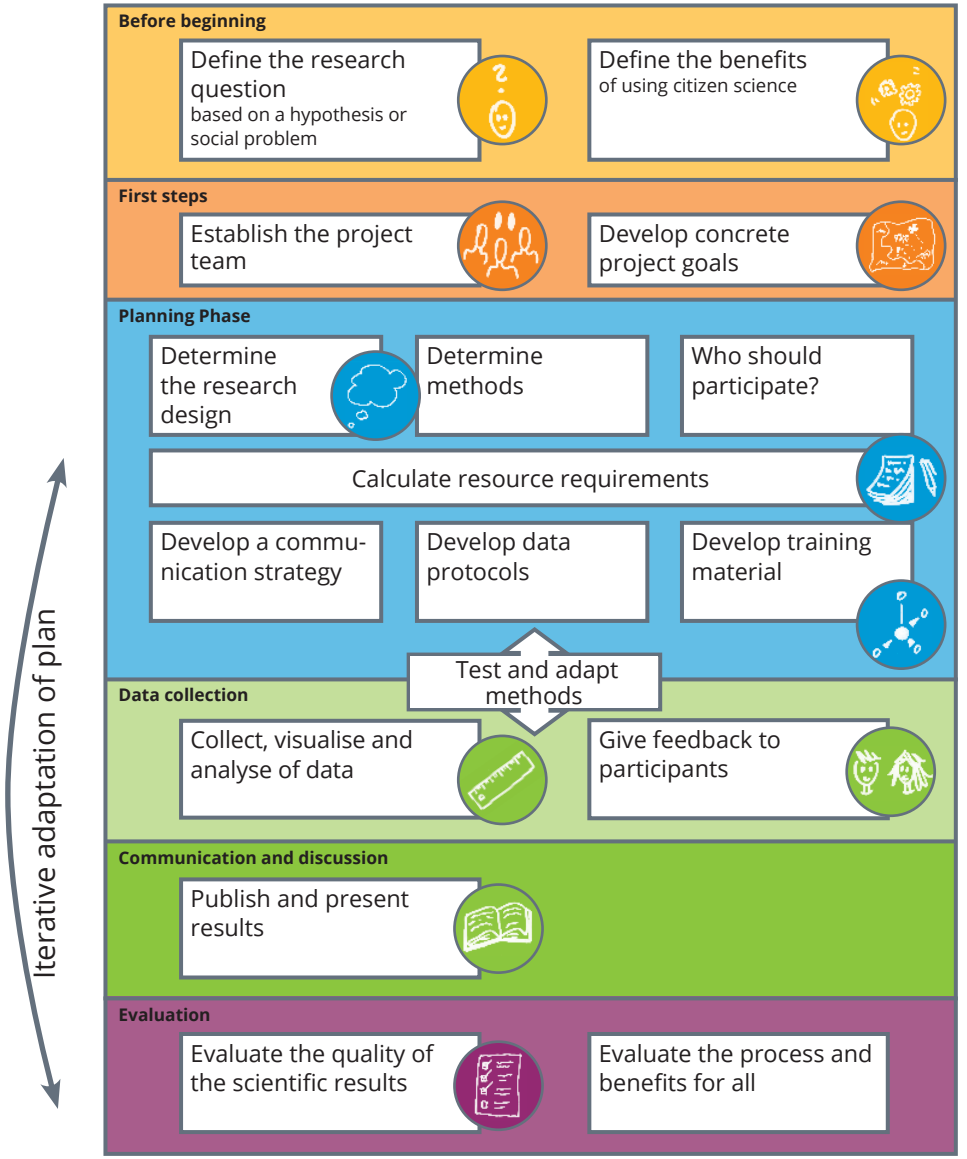
Multi-disciplinary cooperation in the Expedition to Peace project

On the 100th anniversary of the beginning of World War I, the project 'Expedition to Peace' was launched. Coordinated in collaboration with the Historisches Seminar, Lehrstuhl für Neuere und Neueste Geschichte (Chair for Recent and Modern History) and the Arbeitsstelle Forschungstransfer (AFO) at the Westfälische Wilhelms-Universität Münster (WWU), the project aimed to familiarise the interested public and students with events from World War I. It uses methods different from conventional politics and memory-driven approaches, combining art and scientific research in a very distinctive manner.

The project was conceived and organised in cooperation with academic experts from various disciplines, students, pupils and citizen researchers. In the course of the two-year project, nine events were held in five locations. "Ich sehe, was du nicht siehst" (I see what you can't see) focused on the former prisoner of war camp Haus Spital and above all what has become invisible over time. In collaboration with students and academics at the WWU, secondary school pupils took the preliminary results of their World War I history project further and showed the public where exactly the forgotten camp had been. They created an artistic memory lane on the grounds of the erstwhile camp, bringing history to life. **http://go.wwu.de/3you6**

8 How to plan a citizen science project – from start to finish!

Project task



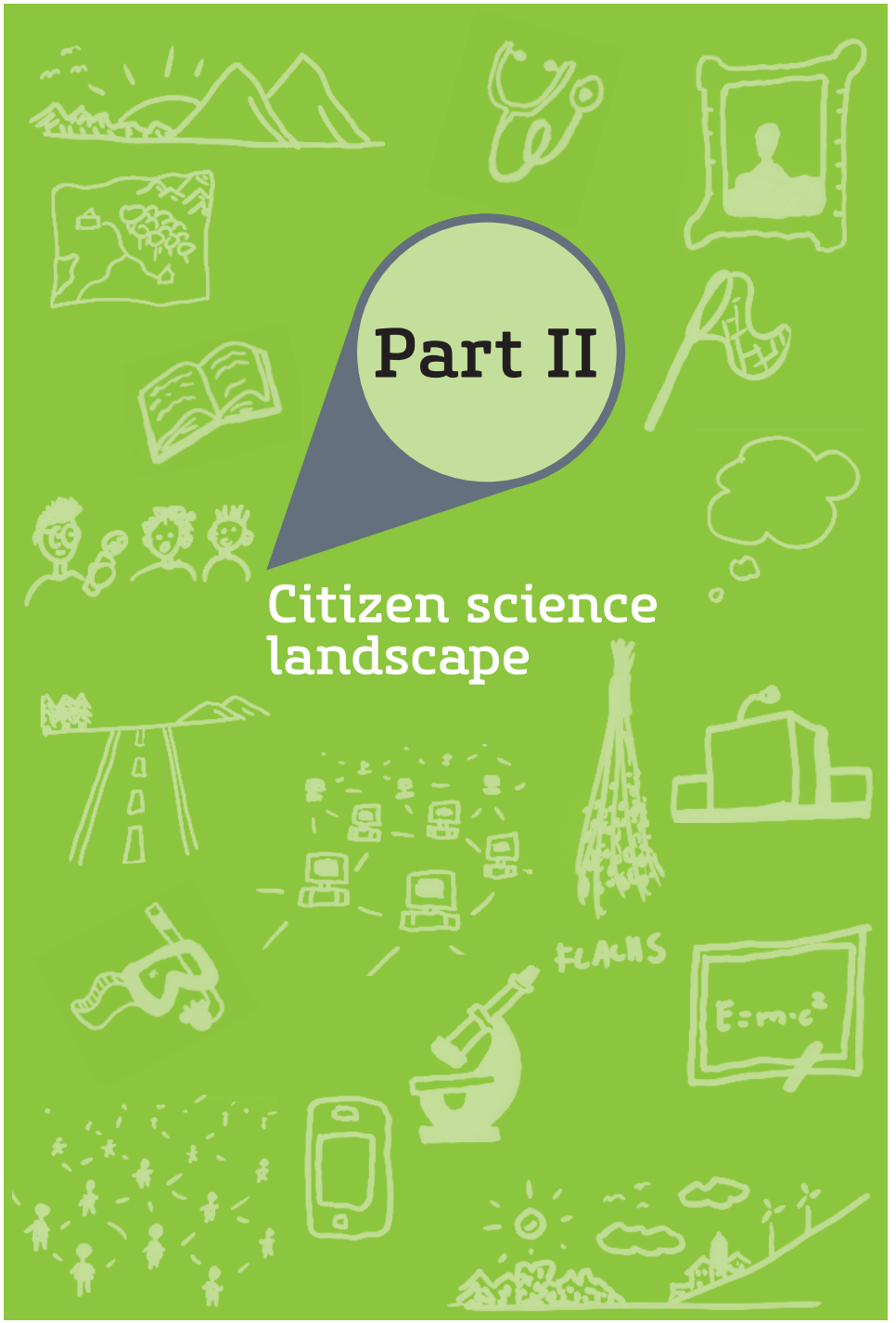
Checklist

Is there a clear research question?	☐
What is the advantage of using a citizen science approach?	☐
Are the necessary skills and interests represented?	☐
How long should the project take?	☐
What resources are required?	☐
How can participants be motivated? What are the benefits for participants?	☐
Do participants need training and if so, how?	☐
How will the project be evaluated?	☐
What infrastructures are required?	☐
Where and how will data be (permanently) stored?	☐
What licences will be used for data/ photos/reports?	☐
Who is responsible for communicating with participants?	☐
How will the results be published and what is the target audience?	☐
How can participants' role be made visible?	☐
What criteria must be fulfilled so that the project can be considered a success?	☐

A citizen science project requires resources and especially time. It makes sense to think about the whole project, from concept development, to identification of partners right through to publishing the results, early in the process. Diagram modified from [15].

Part II

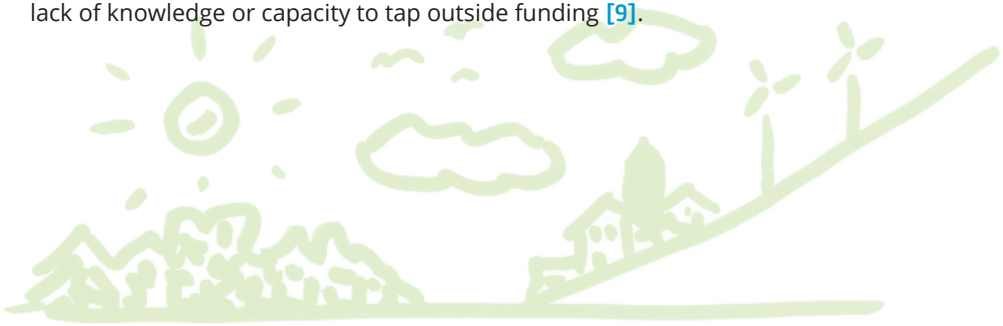
Citizen science landscape



9 Citizen science in nature conservation

Citizen science has been practised successfully in nature conservation projects in Germany, monitoring the long-term development of individual species populations and ecosystems to find out what effect environmental changes have on habitats [13]. These insights lead to recommendations for the protection and care for species, which can lead to the development of concrete policy measures and care programmes that can be implemented by the relevant authorities (e.g. nature reserves, conservation authorities and landscape management groups). Species and ecosystem data are important both in developing new recommendations and evaluating existing care and protection measures at both local and regional levels. In addition, long-term monitoring of selected species and habitats can answer more general questions, such as how climate change effects specific ecosystems or what mechanisms effect the spread of invasive species in different landscapes. Much of the data on biodiversity and the effects of biotic and abiotic factors is collected by volunteer scientists, in particular data relevant to planning for conservation of endangered species.

The large nature reserves in Germany – National Natural Landscapes – particularly biosphere reservations and national parks, serve two primarily purposes. They function as educational centres, with an education for sustainable development (ESD) and environmental education remit. At the same time, they are dedicated to the exploration and observation of nature. Their research activities, as in institutional research, can be exploratory or hypothesis-driven. Depending on the protection area and the relevant authorities, research projects may be carried out in-house or outsourced to third parties, e.g. in the form of expert assessments. The scope and depth of research are hampered by the National Natural Landscapes' insufficient financial resources, lack of knowledge or capacity to tap outside funding [9].



Citizen science can be a useful approach to tackle these challenges. A major task of citizen science projects in conservation areas is motivating and supporting volunteers with the help of professional volunteer coordinators. The volunteer programme in the National Natural Landscapes is called 'Honoring Nature – Volunteers in Parks' (*Ehrensache Natur – Freiwillige in Parks*) and has an online directory that seeks to activate volunteers for nature observation in national parks, nature reserves and biosphere reserves. Participants often ask for visualisations of the collected data. Here, the quick communication of results to participants and collaborating universities and scientific institutions is invaluable.

It is important to be aware of the different legal positions of volunteer activities in contrast to data collected for government purposes when working on private land. For example, entering forests off the main paths must be authorised by owners, users or the reserve management. The general rule is that leaving the main paths is permitted for recreational purposes only, but not for scientific work.

STORY

Remembering the countryside with Landscape Change

Can you still remember the countryside of your childhood? Rural landscapes undergo constant change, becoming increasingly homogenous, but we often don't notice. Landscape Change is a citizen science pilot project that captures the imagination of participants by recreating a collective memory of the countryside. People are asked to look through their family photo albums to find old photographs of rural landscapes and then take a new photograph from the same angle in the same spot. Citizens are also asked to decide whether the changes have been for the better or the worse, and what types of environmental change are likely to result. Scientists from the Leibniz Institute of Ecological Urban and Regional Development (IÖR) and other partner institutions will connect the landscape changes with biodiversity data to find out if there is a connection. In the test region of Saxon Switzerland, everybody got involved: old and young, experienced photographers and amateurs. We were able to reach out to a large section of the population and inspired them to contribute. The countryside seems to be something that people can relate to, something they can understand and that affects their lives. We hope to roll out our project all over Germany.

www.landschaft-im-wandel.de

STORY

Recreational divers and conservationists work together to make our lakes cleaner

Working together to protect nature is something that cannot always be taken for granted. Divers and conservationists have different, sometimes conflicting, interests. Divers often feel that conservationists want to restrict their activities. At the same time, environmentalists worry that recreational divers put their own enjoyment before conservation. The project 'Diving for Conservation' (Tauchen für den Naturschutz) has helped to change this. It enables recreational divers to assess the ecological state of the lakes where they dive. In a unified approach, divers help to record rare and threatened submerged plants and collect data about the state of their lakes, which can then be compared.

Divers benefit from the collaboration with committed conservationists. Their dives become more interesting and they become more aware of the differences between the waterbodies they dive in. The cooperation with recreational divers also aids conservation, as it provides a much more comprehensive picture of the state of the lakes than professional mapping by scientific diving teams could. There are 5,000 lakes in Brandenburg and Mecklenburg-Western Pomerania alone, 80% of which are in a sorry state. Only through cooperation can this trend be reversed.

Further resources

- A manual for citizen science nature conservation: Schierenberg, A., Richter, A., Kremer, M., Karrasch, P., & Bonn, A. (2016). *Anleitung zur Entwicklung von Bürgerwissenschafts-Projekten – Citizen Science in den Nationalen Naturlandschaften*. EUROPARC Germany, Berlin, Helmholtz Centre for Environmental Research (UFZ), Leipzig; German Centre for integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig. Available online at: **www.buergerschaffenwissen.de** (GER)
- Volunteer programme in the German national parks *"Ehrensache Natur – Freiwillige in Parks"*: **www.ehrensache-natur.de** (GER)

10 Citizen science and education

Education and citizen science are intertwined in many ways [4, 10, 11]. Citizen science can often complement existing education frameworks such as Education for Sustainable Development (ESD). It can also be used to attain other educational objectives such as civic engagement or scientific literacy. Many citizen science projects and initiatives educate participants by promoting understanding of scientific inquiry, the research subject, the scientific method or responsible action. Citizen science's educational potential includes individual, social and institutional levels. Citizen science works along the axes of science, education and civic engagement [20].

Citizen science can make a significant contribution to the development of subject competence in citizens, i.e. lifelong learning. Projects should be planned with benefits for **all** participants in mind.

STORY

Education as empowerment in the Lesach Valley

The project 'Landscape and You-th' highlights the connection between regional experiences and cultural landscapes, focusing on flax as a crop in the Lesach Valley in Carinthia, Austria. Pupils aged between 10 and 21 record and re-enact the practical knowledge of contemporary witnesses about traditional methods of growing and processing flax. They share this knowledge through a blog, a documentary and science slams. Their research in the project familiarises pupils with scientific methods and nurtures their empathy for an older generation. The inter-generational dialogue encourages all participants to develop the project further and to engage with cultural landscapes beyond the duration of the project. **www.lesachtalerflachs.wordpress.com**

Further resources

- An education approach that promotes civic empowerment: Levinson, M. (2012). *No citizen left behind*. Cambridge: Harvard University Press.

11 Digital citizen science

Over the past decade, use of the Worldwide Web has changed dramatically, providing huge potential for citizen science. What was known as Web 1.0 relied on top-down information flows; users were rarely given the opportunity to generate content themselves [17]. The transition to Web 2.0 is driven by technological advances that allow everyone – both developers and users – to process, evaluate and share content. These changes go hand in hand with a different use of the Internet that includes a philosophy of sharing and networking.

The current popularity of citizen science can be partly explained by the availability of new technology and the new philosophy of sharing. Web 2.0 opens up new avenues of communication, collaboration and interaction for citizen science. The tools and platforms of the social web in particular have become increasingly part of academic life and revolutionised the way we communicate, collaborate and interact, leading to participation and open discourse. Wikis and blogs are widely used to communicate research ideas and even research results. Virtual research environments are being appreciated as useful workspaces.

Many successful citizen science projects in diverse subject areas – from genealogy to environmental monitoring – take place in the digital world. Projects use a wide range of approaches, from simple smartphone apps with data entry functions to serious games, where users may be unaware of the scientific purpose.

It is important for digital citizen science projects not only to use the potential of the Internet, but also to ensure that applications are suited to the project and that data collection and data use conform to data protection laws.

STORY

ARTigo: Informatics and (digital) art history

ARTigo aims at developing a semantic search engine for digitised works of art. The low quality of current automated methods of art recognition means that human image recognition systems remain critical even in digital databanks. Using paid experts or non-experts is cost-prohibitive, which led to the development of an online platform that offers several games to promote art recognition. Through these short games, players (citizen scientists) describe the content of artwork with keywords. These keywords are then used to develop a semantic search engine. The different games on the ARTigo platform allow the collection of a wide range of keywords, thus enhancing search functionality and making it possible to answer complex research questions.

The tagging of artwork by non-experts relies on the wisdom of the crowd. By aggregating many sets of keywords produced by players, it is possible to generate high-quality results. The idea is to reach out to as many people as possible, which can best be achieved via the Internet. **www.artigo.org**

STORY

Roadkill, developed as a student project

Roads run right through wildlife habitats, including the homes of red deer, wild boar, roe deer and smaller animals such as frogs and lizards. Because of these incursions into natural habitats, many animals are run over and killed at road crossings. The 'Roadkill' project seeks to reduce the number of animals killed by vehicles. It does so by asking citizens to report roadkill on their daily commute via a smartphone app or an online form. These data provide an overview of the number, species and distribution of animals killed on roadways.

Roadkill began as a pilot project with students at the University of Natural Resources and Life Sciences, Vienna to see if it was appropriate for the larger public. The pilot yielded several benefits. The project was evaluated before a wider launch, which led to revision of the recording protocol. Participating students learned at an early stage how to be actively involved in a scientific research project, gaining them practical experience in applying scientific methods. In addition, the pilot led to increased interest in the topic of roadkill and the challenges it posed. The project was first adapted iteratively to the students before being successfully introduced to the public. **www.roadkill.at**

12 Citizen science in the social sciences

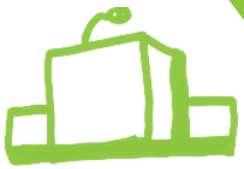
The equitable inclusion of people without academic training in the empirical social sciences and health research has been discussed since the early 20th century. Different traditions and schools of thought developed in different countries, including action research, community-based participatory research, cooperative inquiry and appreciative inquiry. Due to this particular history of participatory approaches both nationally and internationally, the term citizen science is rarely used in the social sciences. The following approaches are widely used and have similarities to citizen science:

- Participative research or action research – an approach that includes the interests of minorities and other disadvantaged groups in order to improve their living conditions [16].
- Transdisciplinary research – research that involves various disciplines and introduces societal inputs in all phases of a research project [5].

Unlike other disciplines, social science research faces the challenge of studying social systems and processes. This means that ordinary people are often involved in research projects, for example as interviewees or survey respondents. Confusingly, many such empirical social research projects are considered participatory because of the qualitative or performative methodology. These, however, must be distinguished from the approaches mentioned above because they are not compatible with the concept of citizen science and active participation in the research process.

The term citizen science has been increasingly used in urban and rural planning projects, such as those interested in guiding development processes or preserving local history and stories in wikis [7]. These projects are often individual experiments and it is difficult to derive generalizable characteristics for citizen science in this diverse field.

STORY



Education in economics and scientific research

The project 'YES! – Young Economic Summit' is a schools project under the patronage of the German Minister for Economic Affairs Sigmar Gabriel. Pupils work in project groups under a teacher's supervision. Each group focuses on an urgent research topic for six months. The aim is to find a concrete solution for a global economic, ecological or social problem. Through training in information collection and the media, young people are taught the basics of academic research. The direct exchange with academics makes science tangible to pupils and allows valuable knowledge to be passed on. Pupils learn that they can shape their economic reality instead of playing an entirely passive role. YES! gives participants a platform to voice their concerns and encourages them take responsibility in helping to shape a future worth living in.

www.young-economic-summit.org

Further resources

- An overview of transdisciplinary methods: Bergmann, M., Jahn, T., Knobloch, T., Krohn, W., Pohl, C., & Schramm, E., Eds. (2010). *Methods for transdisciplinary research: A primer for practice*. Frankfurt a.M.: Campus.
- Participatory methods in the social sciences: Niederberger, M, Eds. (2014). *Methoden der Experten- und Stakeholdereinbindung in der sozialwissenschaftlichen Forschung.* Reihe Qualitative Sozialforschung. Springer. (GER)

13 Citizen Science in health research

Similar to social sciences, health research also developed its own concepts for participation of people without academic training. Again, this is why there are only very few projects that would consider themselves to be citizen science. Some such examples are the participation of patients or parents in online platforms such as **Migraine Radar** (**www.migraene-radar.de**) or the project **Discuss with Us** (*Reden Sie mit*) by the Ludwig Boltzmann Association in Austria, which allows interested members of the public to participate in scientific inquiry by suggesting new study topics on mental health issues. Participatory projects are commonly called participatory health research (PHR), a term coined by the International Collaboration for Participatory Health Research (ICPHR) and the German Network for Participatory Health Research (*Netzwerk Partizipative Gesundheitsforschung*, PartNet). Both networks share a platform to outline common basic principles, quality criteria and guidelines for PHR.

PHR is a neutral umbrella term that summarises projects with a variety of methodologies and practical objectives. The common elements of participatory health research projects lie in the empowerment of non-academic co-researchers and a dual purpose – not only research, but also action is required in order "not only to understand but also change social reality" **[16]**, p. 35.

There are similarities in the concepts of PHR and citizen science, as seen by the German network's recently adopted definition, developed in a multi-step participatory process: Participatory health research is a scientific approach that understands research as a process of co-production by different actors. The research process is organised in partnership by all participants and constantly reviewed with respect to power structures. Throughout the whole research process, co-determination by those whose lives are studied must be maximised. Participants include those individuals whose lives are studied, specialist scientists and decision-makers in health care, social science or education, as well as representatives from organised civil society and scientific organisations. PHR aims at gaining new insights and initiating changes that promote equal opportunities in health" (*Netzwerk Partizipative Gesundheitsforschung* 2015).

Further resources

- A good introduction to participatory health research: von Unger, H. (2013). *Partizipative Forschung: Einführung in die Forschungspraxis*. Reihe Qualitative Sozialforschung. Wiesbaden: VS Verlag. (GER)
- The German network for participatory health research provides resources and offers methods workshops: **www.partnet-gesundheit.de** (GER)
- The Ludwig Boltzmann Association's platform: **www.openinnovationinscience.at** (GER)

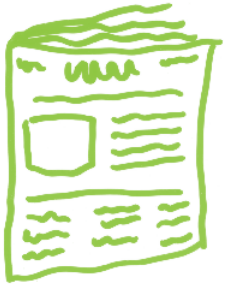
14 Citizen science in the arts and humanities

Many successful citizen science activities take place in the arts and humanities [8]. Volunteer work is often coordinated by independent scientific groups such as the Club for Computer Genealogy (*Verein für Computergenealogie e. V.*, CompGen), which focus national and regional history and family history. The German umbrella organisation for genealogical associations (*Dachverband Deutsche Arbeitsgemeinschaft genealogischer Verbände e. V.*, DAGV) connects over 60 genealogical and heraldic associations in Germany, while the collective *Gesamtverein der deutschen Geschichts- und Altertumsvereine* is an association of 200 historical societies, historical research committees regional historical institutes and working groups. Some German Länder have centres for coordinating preservation issues (e.g. the Bavarian office for monument preservation, the *Bayerisches Landesamt für Denkmalpflege*) that collaborate with local historians and historical groups. The German Society for Pre- and Protohistory (*Deutsche Gesellschaft für Ur- und Frühgeschichte e. V.*) involves citizens interested in archaeology in its work. In addition, public history is an approach firmly rooted in societal engagement that gained popularity in academic research and science communication circles.

Methodical approaches vary widely, from pure crowdsourcing (ARTigo, p. 36) to communicative approaches that include citizens in developing the methodology and research questions (Landscape and You-th, p. 34), as well as largely independent scientific groups. CompGEN makes a data entry system (DES, p. 43) available that gives access to historically valuable resources such as address books, registry records or casualty lists, which have been transcribed and are now available to the public as references. The society collaborates with public archives and regional genealogical societies. Historic preservation authorities often provide in-depth workshops for volunteers before they start work on their own initiative with regular feedback. The association of local historical group in Lower Saxony (*Niedersächsische Heimatbund*) includes many private individuals in its network, many of them local historians with very specific expert knowledge that they share with the public through publications. The association brings together interested citizens and members of the academic community. Finally, we would like to highlight historical re-enactment (see Lab for Experimental Archaeology, p. 10) as an important approach where volunteers explore historical details in order to reproduce historical artifacts and their means of production.

Here is where citizen science projects in the arts and humanities reach their limitations. It is not only difficult to stimulate equitable communication between citizen scientists and academia, but also connections between various disciplines. A project's long-term success requires not only sharing results and methods with the public, but also exchanging experiences with associations and umbrella organisations as wells as other projects and approaches.

STORY



Casualty lists from World War I

*Public archives in towns or regions, universities or churches and public libraries contain hundreds of kilometres of historically valuable sources that are handwritten, typed or printed. Archival records from the 19th century and earlier is printed in black letter, typefaces difficult for automated digitalisation programs to decode. Digitising sources such as church and registry records, lists of war graves or historical address books facilitates the transfer of their contents into databases. The Association for Computer Genealogy (*Verein für Computergenealogie e. V., *CompGen) has developed a Data Entry System (DES) to manage the digitalisation of important historical records by volunteers.*

One crowdsourcing project by CompGen indexed the casualty lists of World War I. This made over 8.5 million records available to DES that can be used in academic and private research.

wiki-de.genealogy.net/Verlustlisten_Erster_Weltkrieg/Projekt

Culture in the Corridor STORY

*Small monuments and landmarks, often referred to – based on their Catholic origins – as Marterl, often have a very special meaning for people. The project 'Culture in the Corridor' (*Kultur in der Flur*) shows these small monuments online, including information gathered by interested amateurs and experts – free of charge and supplemented with images. The online platform lets users locate monuments on Google maps, write comments or post links on social networks. There are also viewing suggestions for similar monuments or monuments nearby. For a small fee, users can have the comments verified by experts from the lower Austrian education and cultural history association* Bildungs- und Heimatwerk Niederösterreich (BHW) *and get an expert seal of approval.*. **www.marterl.at**

Further resources

- A good introduction to citizen in the arts and humanities: Smolarski, R. & Oswald, K., Eds. (2016). *Bürger Künste Wissenschaft. Citizen Science in Kultur und Geisteswissenschaften* (Band zur gleichnamigen Tagung, 21.–23.09.2015, Universität Erfurt). Computus Verlag, Gutenberg (in Druck, vsl August 2016). See also [8]. (GER)

15 Citizen science internationally

Citizen science is currently experiencing great popularity in Germany and internationally, which is reflected in a surge in projects and the consolidation of initiatives and emergence of networks. This also includes the creation of dedicated citizen science associations at the international level, which seek to increase professionalism in the field of citizen science [3].

The extension and expansion of pilot projects is a sign that citizen science is becoming more organised. The British Open Air Laboratories (OPAL) programme is a good example. The project began as a biodiversity and environmental monitoring programme in England and has expanded in recent years into Scotland, Wales and Northern Ireland, reaching roughly 800,000 participants. MicroPasts and the Portable Antiquities Scheme are both long-term projects run by the British Museum that allow citizens to take an active part in the transcription and placement of historical sources and findings or locating and entering information relevant to cultural monuments into a common, open database. Benefits include not only the large number of people taking part in making Britain's cultural heritage accessible, but above all the growing appreciation for the work of archaeologists and historians.

We are also seeing an increase in collaborations between citizen science practitioners. Numerous different fields, such as environmental monitoring (e.g. the British Ecological Society and Cornell Lab of Ornithology), open science (e.g. Citizen Cyber Science Center and Zooniverse) and social science-based action research, are well represented. Subject networks often develop along thematic fields or based on cross-disciplinary issues, which highlights the importance of citizen science inter- and transdisciplinary research [18]. More recently, networks have begun to cooperate beyond thematic or disciplinary areas at national and even European level. In the German-speaking world in particular, national citizen science coordination sites and projects have developed, connecting local citizen science practitioners and projects, coordinating PR and answering questions from interested members of the public and stakeholders. Beyond "Citizens create knowledge" (GEWISS) in Germany, Austria and Switzerland also host various citizen science networks, web platforms and national conferences. In Austria, the Ministry for Science, Research and Economic Affairs has funded several calls related to citizen

science and the independent platform "Austria researches" (*Österreich forscht*) **www.citizen-science.at**, coordinated by the Institut für Zoologie at the Universität für Bodenkultur Wien (BOKU), is home to over 30 projects and organised the Austrian citizen science conferences in 2015 and 2016. In Switzerland, Science et Cité is a foundation that fosters dialogue between science and society and spearheads the Citizen Science Switzerland network founded in 2014.

At the European level, the European Citizen Science Association (ECSA) is the umbrella organisation that supports citizen science by building networks, promoting exchange, expanding capacity and conducting research. ECSA was registered as a charity in Berlin in 2014 and has its headquarters at the Museum für Naturkunde Berlin. The association supports organisations and individuals that carry out citizen science projects, referred to as citizen science practitioners. The association also carries out research on citizen science. ECSA has published its good practice guide for citizen science in 20 languages, making a significant contribution to the development of the field and its acceptance in the European science policy arena.

STORY

iSPEX: Local coordination of an international project

Athens, Barcelona, Belgrade, Copenhagen, London, Manchester, Milan, Rome and Berlin – all are exciting European cities that are popular for different reasons. Between 1 September and 15 October 2015, particulates were measured all these cities. The iSPEX project is planning to form a widespread, flexible network for collecting particulate data and carrying out highly targeted geographic analyses. The iSPEX add-on is a mechanical spectrometer and polarisation meter in a plastic case that can be attached to a smartphone. It measures the refraction and polarisation of sunlight and thus local particulate pollution. The many recorded images facilitate concentration estimates, chemical composition and distribution of particulate size at a given time. In Berlin, the project is coordinated by the non-profit MINT Impuls in collaboration with the Institute for Meteorology at the Freie Universität Berlin. The European-wide project is coordinated in other countries by institutions including the National Observatory in Athens, ICFO and CREAL In Barcelona, the Institute for Physics in Belgrade, the Danish Environmental Protection Agency in Copenhagen, Institute of Physics in London, the Italian Aerosol Society and Citizens for Air in Milan as well as ISAC-CNR in Rome. **www.ispex.nl/en/**

Further resources

- Austrian Centre for Citizen Science: **www.zentrumfuercitizenscience.at** (GER)
- Austrian citizen science platform: **www.citizen-science.at** (GER)
- Citizen Science Association (CSA) website: **www.citizenscience.org**
- European Citizen Science Association (ECSA) website: **www.ecsa.citizen-science.net**
- German citizen science platform: **www.buergerschaffenwissen.de**

Literature

[1] Bonn, A., Richter, A., Vohland, K., Pettibone, L., Brandt, M., Feldmann, R., Goebel, C., Grefe, C., Hecker, S., Hennen, L., Hofer, H., Kiefer, S., Klotz, S., Kluttig, T., Krause, J., Küsel, K., Liedtke, C., Mahla, A., Neumeier, V., Premke-Kraus, M., Rillig, M. C., Röller, O., Schäffler, L., Schmalzbauer, B., Schneidewind, U., Schumann, A., Settele, J., Tochtermann, K., Tockner, K., Vogel, J., Volkmann, W., von Unger, H., Walter, D., Weisskopf, M., Wirth, C., Witt, T., Wolst, D., & Ziegler, D. (2016). *Green Book Citizen Science Strategy 2020 for Germany. GEWISS publication*. Available online at **www.buergerschaffenwissen.de**

[2] Bonney, R., et al. (2009). Citizen science: A developing tool for expanding science knowledge and scientific literacy. *BioScience*, 59 (11), 977.

[3] Göbel, C., Vohland, K., Cappadonna, J., Newman, G., & Zhang, J. (in press). More than just networking: How practitioner associations contribute to the professionalization of citizen science globally. In: Ceccaroni, L., Piera, J. (eds) *Analyzing the role of citizen science in modern research*, IGI Global.

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Glossary of English and German terms

Note: In cases describing German-language terms, the original term is noted in italics.

Term	Definition	Sources and examples
Amateur science, popular science *(Amateurwissenschaft, Populärwissenschaft)*	Amateur science describes the scientific activities of citizens who do not earn their living as scientists (→ *Laienforschung*). Although the word "amateur" is derived from amare – to love – these terms are often considered derogatory.	Finke, 2014; Mahr, 2014
Citizen science and *Bürgerforschung*	*Bürgerforschung* is the literal German translation of "citizen science". In German, it includes the long research tradition of independent scientific societies.	Irwin, 1995; Finke, 2014
Co-creation / Co-design / Co-production	These terms are used to describe the cooperative development (and implementation) of research and innovative projects involving scientists and other members of society. → transdisciplinary research	
Crowdsourcing / Crowd science	Crowdsourcing entails the mobilisation of large groups of individuals from outside of research, government or business, usually to perform clearly defined tasks, often in digital projects. In crowd science, such tasks are connected to science projects and typically involve collecting or analysing data (e.g. through pattern recognition, photo tagging or digitisation of handwriting).	(Bücheler & Sieg, 2011; Franzoni & Sauermann, 2014
DIYBio / BioHacking	DIYBio is a special branch of DIY in biological science, where private individuals who often own expensive equipment, look into biological problems.	
DIY science	Do-it-yourself or DIY science is used as an umbrella term for community-based initiatives dealing with scientific and technological issues. The term has recentlybeen in the spotlight in the context of the maker or hacker culture. → FabLabs serve as spaces for DIY science.	Charisius, Karberg & Friebe, 2013; Seyfried, Pei & Schmidt, 2014
FabLabs, open laboratories	FabLabs is an artificial word derived from Fabrication Laboratories that describes open spaces where conventional and/or digital tools are used to produce objects or machines, often in collaboration with scientific institutions and independent groups. → DIY science	Lange, 2015

Term	Definition	Sources and examples
Independent or volunteer scientific groups *Fachgesellschaften*	*Fachgesellschaften* is a difficult term to translate outside of the German context, but means roughly independent volunteer scientific groups. These groups are generally organised within scientific disciplines; their members may be professional scientists or experienced amateurs often with decades of accumulated knowledge and expertise, who earn their living in other ways.	[12]
Lay or hobby research *(Laienforschung; Hobbyforschung)*	Laienforschung, literally "lay research", describes the research activities of citizens who do not earn their living as scientists (amateur science). A lay person can be seen as inferior to experts in terms of (scientific) knowledge and the term is thus sometimes considered derogatory.	Finke, 2014
Mode 2 science	Mode 2 science is a term coined in the 1980s to describe a change in the organisation and epistemology of knowledge generation. It is characterised by an increasing importance of socially relevant research and the participation of societal actors in knowledge-generation processes. This critical approach is often used as to support the demand for transdisciplinary research.	Nowotny, 1999
Open innovation	Open innovation is a strategic opening of innovation processes in research institutions and companies to external knowledge and the exchange of knowledge between different organisations in order to promote innovation.	Bücheler & Sieg, 2011; Franzoni & Sauermann, 2014
Open (digital) science	Is the successor term of Science 2.0 and includes use of the Internet and social media for science and innovation, a strategy currently favoured by the European Commission.	Bücheler & Sieg, 2011; Franzoni & Sauermann, 2014
(Participatory) action research	Action research was developed in response to purely experimental research with a practical orientation in order to resolve real-world problems. Participatory action research includes citizens in research work. It was developed in the 1940s in social psychology as an alternative to mission-free science considered alienating to theory and practice.	
Participatory (health) research	Participatory research includes the participation of various groups in the research process and can be considered an umbrella term. It is often used in health research..	[16]; Wright, 2013 → S. 40

Term	Definition	Sources and examples
Post-normal science	Post-normal science is a participation-based methodology for scientific research that takes into account uncertainty, decision pressures and contested values. The approach looks at increasing knowledge requirements for political decisions and works from the hypothesis that modern societies experience increased risk and uncertainty as natural outcomes of scientific and technological progress (e.g. Beck, 2015). Against this background, a case is made for the inclusion of societal groups.	Ravetz, 2006
Reallabore	Reallabore is a German term for institutions where scientists are involved in real processes of change, such as urban renewal or new mobility or energy schemes. From the onset, individuals that do practical work in local authorities, social and environmental organisations are included in the research project. New knowledge is generated in an open process, focused on practical results. The term originates from transformation research and points to places and institutions that are linked to real-world experiments.	Schneidewind, 2014
Responsible Research and Innovation (RRI)	Responsible Research and Innovation (RRI) is currently championed mainly by EU research funding. It refers to the inclusion of all citizens in research and innovation processes. It can entail a transdisciplinary research approach or enhanced science communication. RRI rests on the following pillars: public engagement, open access, gender equality, ethics and science education.	Hennen & Pfersdorf, 2014
Science 2.0	Science 2.0 is used to summarize changes in scientific work through modern information and communication technology, particularly the Internet and social media. Like its predecessors Cyberscience, eScience and digital humanities, it describes not only changes in scientific publication (e.g. open access), but also the increased interactivity and accessibility of research and researchers in the age of the Internet. Citizen science projects, especially Citizen Cyberscience and crowdsourcing can be considered related phenomena to Science 2.0.	Bücheler & Sieg, 2011 → S. 35

Term	Definition	Sources and examples
Transdisciplinary research	Transdisciplinary research describes not only the inclusion of different disciplines in the research process (often referred to as multidisciplinary or interdisciplinary research) but also the further inclusion of various stakeholders from outside academia, e.g. in industry, politics and civil society. In contrast to citizen science, transdisciplinary research sees such participants as stakeholders, whose opinions and interests must be considered for research to be relevant. The term is often used in sustainability research.	[5]; [7]
Volunteer research *Ehrenamtliche Forschung*	Volunteer research signifies a long tradition of largely research-supporting activities, in particular data collection, conducted by volunteers.	

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Notes

Notes

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BBIB Berlin-Brandenburgisches Institut für Biodiversitätsforschung

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museum für naturkunde berlin

Freie Universität Berlin

Friedrich-Schiller-Universität Jena

IGB Leibniz-Institut für Gewässerökologie und Binnenfischerei

Leibniz-Institut für Zoo- und Wildtierforschung im Forschungsverbund Berlin e.V.

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