Storytelling in Citizen Science – Potential for Science Communication and Practical Guideline

Conference Paper · January 2018

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EXPANDING HORIZONS
Österreichische Citizen Science Konferenz
2.-4. März 2017

bmwfw
Bundesministerium für Wissenschaft, Forschung und Wirtschaft

MINISTERIUM FÜR EIN LEBENSWERTES ÖSTERREICH

wirtschafts agentur wien
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UNIVERSITÄT SALZBURG

Ludwig Boltzmann Gesellschaft

Austrian Citizen Science Conference 2017

AGES, Vienna

March 02-03, 2017

www.citizen-science.at

Österreich forscht
www.citizen-science.at

AGES

FWF
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frontiers Abstract Book

AUSTRIAN CITIZEN SCIENCE CONFERENCE 2017

Expanding Horizons

ISBN: 978-2-88945-367-2
DOI: 10.3389/978-2-88945-367-2

March 02-03, 2017, AGES, Vienna.

The motto of the Austrian Citizen Science Conference 2017, organised by the platform “Österreich forscht” (www.citizen-science.at) and the Austrian Agency for Health and Food Safety Ltd. (AGES), is “Expanding Horizons”. Citizen science projects and initiatives will present and discuss their results and plans, but also their challenges and issues.

Citizen Science has grown rapidly over the last years in Austria. Since 2015 the platform “Österreich forscht” (www.citizen-science.at) organizes an annual citizen science conference, where researches, practitioners and interested citizens exchange experiences, discuss new methods and connect to each other. Under the motto “Expanding Horizons” the focus of the conference in 2017 was on how people can participate in projects and what is needed to increase participation. Workshops, panel discussion and presentations addressed these questions in various fields of research.

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Recent Developments in the Austrian Citizen Science Landscape

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Citizen science has progressed immensely in the last years. International and national organizations, societies, and institutions recognize the big potential in including lay-people in scientific discoveries and projects. The Citizen Science Association in the United States (http://citizenscience.org/), the Australian Citizen Science Association (http://www.citizenscience.org.au/), and the European Citizen Science Association (https://ecsa.citizen-science.net/) all foster this method on an international level by connecting scientists, citizens, politicians, and administrators. Also on, national-scale initiatives exist with the aim to connect citizen science actors to learn from each other and do a lot of awareness projects for citizen science.

One of the first national initiatives in Europe was the Austrian platform *Österreich forscht* (www.citizen-science.at). It was established in 2013 and connects scientists, citizens, and citizen science actors in general. On its website, it displays citizen science projects that invite people to participate all over Austria. More than 50 projects can be found so far. Another objective is to increase the knowledge and the quality of citizen science in Austria.

The number of peer-reviewed publications from Austria in the sector of citizen science increases shortly after *Österreich forscht* was launched in 2013 (Figure 1). Since the first publications in 2014 and 2015 were already submitted at the time the platform was launched, the platform probably had little to no effect on these papers. However, the increase indicates that the platform was launched in a time when citizen science made its first appearances in Austrian academia. Although, scientific projects with public participation exist for more than 150 years in Austria, the terminology for this process was different for every research and geographic area. Based on the increase in publications in 2016 and 2017, we can infer that *Österreich forscht* and the annual Austrian Citizen Science Conference have enforced the use of the term citizen science in academia in Austria.

In 2015, the coordinators of *Österreich forscht* organized the first Austrian Citizen Science Conference in Vienna at the University of Natural Resources and Life Sciences. The conference consisted of five oral presentations from different disciplines that all highlighted existing citizen science initiatives, potentials and challenges of citizen science. A poster session and a workshop on the future of citizen science in Austria completed this one day conference. More than 70 people attended this kick-off conference.

In 2016, the second Austrian Citizen Science Conference took place at the *Wassercluster Lunz* in Lunz am See, Lower Austria. More than 60 international participants joined the two-day conference with 22 oral presentations, two workshops on data quality and on prerequisites that are needed to foster citizen science in Austria, a mini barcamp and a poster session. The focus of this second conference clearly was on sciences. However, one presentation from the humanities showed that citizen science was about to expand its reach.

This year, the third Austrian Citizen Science Conference was held in Vienna. The *Austrian Agency for Health and Food Safety* (AGES) hosted the three-day event, with 9 sessions and 11 workshops. A public citizen science day at the *Natural History Museum, Vienna* gave interested people the opportunity to test and to experience citizen science projects by themselves. Over 200 people attended the first two-day conference at the AGES, and more than 2000 guests were welcomed at the citizen science day. Very astonishing was that the humanities dominated the conference in regard to the number of sessions and presentations.

Over the last years, not only the conference enlarged and the number of publications increased (Figure 1), but also the number of organizations publishing work conducted with citizen science got more. Whereas in the beginning, only a small amount of institutions worked together with citizens in scientific projects, but now the citizen science landscape gets more and more diverse. This was also confirmed by a recent study by Pettibone et al. (2017).

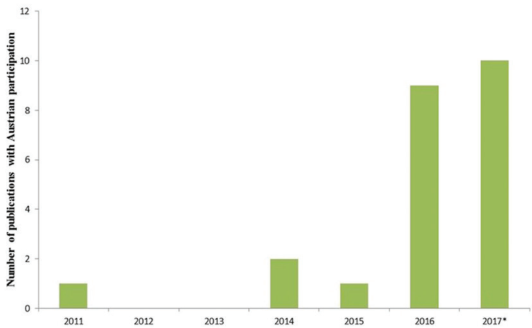

FIGURE 1: Number of peer-reviewed publications with participation from Austrian organizations from 2011 to 2017 (source = Web of Science). *Publications until 31st of October 2017.

Similar to the Austrian Citizen Science Conference, also the diversity of research areas of peer-reviewed publications increased in Austria (Figure 2). In the beginning, citizen science was very focused on ecology and remote sensing. Currently, also the humanities and social sciences are very active in this field.

The platform "Österreich forscht" and the Austrian Citizen Science Conference accompanied this development over the last 4 years in Austria. All the projects on the one hand, and the platform and the conference on the other hand, made citizen science in Austria what it is today.

The following contributions to these conference proceedings from various research areas and institutions give a short glance on the diversity of the recent citizen science activities in Austria. Contributions range from disciplines, such as biodiversity research, archaeology, arts, or philosophy to more general concepts of participation and quality standards. This shows the impressive extension of citizen science in Austria from natural sciences to the humanities and beyond, however, it is only the tip of the iceberg and we are confident that in the future more will be read on citizen science in Austria.

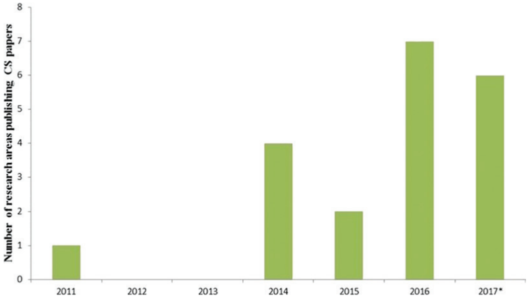

FIGURE 2: The diversity research areas publishing citizen science papers from 2011 until 2017 in Austria (source = Web of Science). *Publications until 31st of October 2017.

Keywords: network, publications, conference, terminology, public participation, humanities

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Quality Criteria for Citizen Science. A Report on a Session at the Austrian Citizen Science Conference 2017

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Today, there are several proposals for quality criteria for good practice in citizen science (Bonney et al., 2009; European Citizen Science Association (ECSA), 2015; Heigl and Dörler, 2016; Pettibone et al., 2016; University of Zurich, 2015). Among other things, they refer to the scientific character of projects, issues of project management, evaluation, quality assurance, presentation and exploitation of results and recognition of achievements. Seemingly, all of the aforementioned quality criteria catalogues have been proposed by research organisations. Which and whose needs do they reflect and to whom are they directed? How are the achievements of citizen scientists officially recognized? How do the criteria protect against instrumentalisation and safeguard research integrity and quality? The contributions to this session discussed quality issues in citizen science from different angles.

Brigitte Tiefenthaler presented reflections on an evaluation study and she has finished in the autumn of 2016. The Austrian Federal Ministry of Science, Research and Economy asked to conduct an accompanying evaluation of eight citizen science projects to find evidence for support measures useful in adding funding, what has to be taken into account when designing citizen science projects, and what could contribute to embedding citizen science into research organisations. This showed that citizen science does not correspond with the usual funding schemes. Quality criteria applied to conventional research projects were not fully appropriate for citizen science projects; they do not sufficiently reflect citizens' demands. In the beginning, academic researchers underestimated the complexity of communication with citizen scientists. Attending non-scientific events and generally maintaining contact with the citizen scientists played an important role in conducting projects successfully. Ultimately, the project durations were too short and there was not sufficient time for all the communication demanded by citizen scientists. One of the reasons for this was the projects' lead times that in general were quite long. Identifying and reaching out to citizen scientists required more time than planned. In addition, using apps created technical challenges. Maybe communication was underestimated, because scientists assumed that the usual project routines would suffice. They did not sufficiently take into account the different personal time orientations of scientists and citizen scientists. Some communication activities, citizen scientists asked for are not considered as part of scientific research and are not rewarded by research institutions. Finally, Tiefenthaler raised further questions: How does it impact on quality if research and project topics are given? How do we handle the tension between research organisations' obligation to international excellence and the regional nature of most citizen science projects?

Barbara Strobl presented a concrete project, her dissertation project *CrowdWater,* which she is conducting together with other PhD students. In this project, citizen scientists estimate quantitative hydrological data such as water levels and submit them by a smartphone app adapted for this project. Though this way of data retrieval allows for retrieving a larger sample of hydrological data, their quality is inferior to traditional measurements. So it was tried to compensate inferior data quality with more measurements in a given time and area. In this project, quality focuses mostly on data. Measures for safeguarding data quality are correspondingly extensive. Highly improbable measured values are filtered out. Citizen scientists are trained how to retrieve and submit data. Furthermore, they monitor each other (peer monitoring). Their estimates are checked against other data, e.g., there is a so-called bias adjustment for underestimated width of rivers, and also other steps are taken. The PhD students try to find out how well instructed citizen scientists have to be and how extensive trainings can be to be still accepted. There are uninformed citizen scientists, ones that get practical advice and others who participate in training on measuring hydrological data. Besides, experienced citizen scientists train others. By trying to find out how future citizen science projects are best designed to make training of citizen scientists most efficient, the project goes beyond run-of-the-mill hydrology projects. But, the quest for efficiency does not go as far as considering communication with citizen scientists of less importance. The app offers an on-line game on estimating level values; there is an on-line discussion forum for all participants; and there are Snapchat[1] field campaigns of citizen scientists meeting to make joint estimates. The project is building a community with social media.

In her contribution, Pamela Bartar presented a metaperspective on the session topic. Illustrated by an example from a completely different field, namely the City of Vienna's attempt from 2004 to 2011 to bring a grassroots approach to funding of cultural projects – NetNet -, she outlined fundamental questions of quality assessment: What does it involve and who asks for it? She gave reasons for her view that the self-understanding of an organisation determines its relation to quality criteria, its own and the ones imposed on it, because an organisation's definition of quality is also a statement about the organisation itself. This would apply to citizen science, too. According to Bartar, NetNet failed because the artists could not agree on a common understanding of quality and criteria for assessing quality. Instead of building a community, the project created discords amongst its participants.

1 Snapchat is an image messaging service by Snap Inc.

There were critical comments from the audience. If quality is defined by its objective, is sometimes citizen science an objective for itself? What is the added value of citizen science for the sciences? Of course, these questions cannot be answered on a general level, but it makes sense to ask oneself when setting out for a citizen science project if it offers benefits not to be had without citizen scientists. In this session, it became clear that successful projects adhere to scientific standards and offer conditions of participation considered as favourable by citizen scientists. Understood as a research partnership, citizen science projects demand from scientists and funders to step into the shoes of citizen scientists and assess project routines and assumptions to avoid that a project is informed by scientific and administrative standards only. We are only at the beginning of developing quality standards that go beyond normal quality control and assessment of research.

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Criteria for Research Funding Programs in Support of Citizen Science

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In 2014, the Austrian Federal Ministry of Science, Research and Economy launched a pilot phase to examine how citizen science projects work in practice, and to find out, if they can they be funded like "normal" research projects or else which specificities a research funder should consider. Eight pilot research projects were selected to test the involvement of citizens in crowd sourcing approaches. In an accompanying study, we analyzed these projects and developed recommendations for research policy measures in support of citizen science. Our study shows how competitive funding programs can accommodate the needs of citizen science, especially regarding project design, eligible costs, additional support, and the link between project funding and institutional governance. We also came up with findings about (new) types of competences needed both by project leaders and by citizen scientists.

INTRODUCTION

How do citizen science projects work – in a very practical sense? Can they be funded like 'normal' research projects or are there specificities a research funder should consider? In 2014, the Austrian Federal Ministry of Science, Research and Economy launched a pilot phase to find answers to these questions: eight pilot research projects were selected to test the involvement of citizens in crowdsourcing approaches. In an accompanying study, we analyzed these projects and developed recommendations for research policy measures in support of citizen science. Our study shows how competitive funding programs can accommodate the needs of citizen science, especially regarding project design, eligible costs, additional support, and the link between project funding and institutional governance. We also came up with findings about (new) types of competences needed both by project leaders and by citizen scientists.

METHODOLOGY

This article is based on a study performed between September 2015 and September 2016. The key task was to analyze eight citizen science pilot projects, funded in the 'Sparkling Science Program'[2]. We took a qualitative approach: two semi-structured

2 Information on the program: https://www.sparklingscience.at/en. Information about the pilot projects: http://www.youngscience.at/young_citizen_science/young_citizen_science/ (in German).

face-to-face interviews with the project leaders and leading team members for each project at different stages of their implementation; interviews with the program owners at the ministry and the implementing agency; and participating observation at two workshops, where the project teams exchanged experience.

The pilot projects performed research in fields as different as allergology, animal ecology, climatology, nursing science, political sociology, remote engineering, seismic, and water quality, and they used two different approaches to citizen science: they involved schools as research partners on an equal footing, i.e., already in the planning stage, and they developed and implemented crowdsourcing approaches during the pilot projects.

KEY FINDINGS

The idea that "everybody can be a scientist" is a myth: Citizen scientists need competences (and sometimes training, too).

Citizen science is more than opening the scientific space to anybody who wants to join: our study showed that in any given citizen science project, the requirements for participating citizens are often demanding, for example:

- specific skills or knowledge, e.g., the ability to identify a plant or animal correctly
- commitment and persistence, especially when it comes to experimenting or to observing an object repeatedly
- presence at or access to certain places, e.g., a garden
- (access to) a certain infrastructure.

Therefore, it was a challenge for the pilot projects to identify the proper target group(s) and to define their task in the project in such a way that the citizens could really add value. It proved helpful to define and test the research tasks for the citizens "in the crowd" with the school partners.

Researchers leading to citizen science projects need communication skills and resources to establish contacts with citizens and to nourish these relationships.

To involve citizens in a research project, it is necessary to identify the target groups and the paths to reach them, e.g., via specialized associations or events. However, the share of eligible traveling and communication costs is limited in grant agreements. Consequently, cultivating these options systematically went far beyond the resources of the observed pilot projects.

Nourishing established contacts often proved equally challenging and surprising. (Highly motivated) citizens would ask all sorts of (off-topic) questions, but for fear of losing their commitment, researchers decided to react and at least signpost or explain, and not to ignore such issues. Project teams also invested significant effort in providing feedback and in reporting about progress made and results achieved.

Communication with the citizens requires skills which are rarely trained in research education – not only generic communication skills but also expertise in developing and maintaining the digital interfaces often applied.

Citizen science projects have to align several timelines in parallel.

In the pilot projects, managing multiple timelines proved challenging facts, which includes:

(i) the 'proper time' of the subject of research, e.g., the season for observing a natural phenomenon;

(ii) the 'proper time' of the targeted citizens, e.g., the timing of the school year;

(iii) the 'proper time' of the "real project": like many grant-funded research projects, most of the pilot projects were parts of a larger, longer-term research agenda of the research groups or their institution, i.e., they were only one step in something we call the "real project". Certain types of citizen science projects should even be considered research infrastructures rather than just projects with a clear start and end date. This holds in particular for large (panel) data collection initiatives, such as phenology networks.

These timelines need to be aligned with each other and with the timelines of the funding program: submission dates, time to contract, eligible project durations, etc. All pilot projects struggled with the time and effort needed. This may at times mean "more talking than research to make research possible", but in typical project funding contracts, there is an upper limit to eligible communication costs.

CONCLUSIONS FOR THE FUTURE DESIGN OF FRAMEWORK CONDITIONS FOR CITIZEN SCIENCE PROJECTS

We have identified the following key issues to be considered when designing a funding program in support of citizen science projects:

- allow for multi-annual project durations with flexible starting dates. Two years, as tested in the pilot projects, have proofed too short in most cases.

- allow for resources dedicated to identifying the target group citizens, and to the design, development, and testing of the interfaces to the citizen scientists.

- make sure project teams schedule sufficient resources for communication with the citizens, to motivate them for participation and – key in long-term research endeavors – to “keep them hooked”.

- support the exchange of experience and the use of existing platforms (especially for the use of electronic devices and digital data collection tools) as citizen science is new to many researchers.

Citizen science is not a means to make research cheaper! If done well, however, citizens can contribute to research in a unique way which would not be possible without their involvement.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

AUTHOR CONTRIBUTIONS

Both authors have contributed equally to this research.

ACKNOWLEDGMENTS

The authors thank all persons interviewed, especially the representatives of the pilot projects, for their time and openness.

FUNDING

This article is based on research contracted by the Austrian Federal Ministry of Science, Research and the Economy, Unit V/4.

Keywords: citizen science, research funding, communication, data collection tools, schools, crowdsourcing

Degrees of Participation in Citizen Science Projects. An Analysis of Participatory Projects Listed in English-Language and German-Language Citizen Science Project Directories

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Citizen science projects are characterized by different degrees of volunteer participation. Defining these levels of participation is a continuing concern within the citizen science discourse. In the literature, these levels range from data collection by members of the public to co-creation of research content and processes by academics and citizens. For this analysis, two typologies of citizen participation are used. They focus on the researcher's point of view or the use of a contributor's cognitive abilities. The objectives of this research are to group citizen science projects into distinct types of participation. This research sheds new light on the degrees of participation prevailing in citizen science projects. For each project, task descriptions and information explaining the participatory approach were examined. The review of 1,691 citizen science projects from all disciplines in English-language and German-language project directories revealed that projects are dominated by crowdsourcing. This suggests that the majority of the projects that are listed in these directories aim at obtaining input from a large number of people. This means that members of the public primarily collect data for research projects. Only a marginal number of projects involve citizens in the entire research process. Overall, there was no significant difference between German-language and English-language project directories. However, it is interesting to note that crowdsourcing for science has many forms. A possible explanation for the dominance of crowdsourcing might be that researchers see participation in citizen science projects as a means and not as an end. Researchers listing their projects in directories might aim at enhancing efficiency and not at giving control to members of a community. These findings may be somewhat limited by these directories as they might exclude some forms of participatory research. Further work is required to better understand the complexity of participation in citizen science projects.

INTRODUCTION

While a variety of definitions of citizen science have been suggested, their common element is public participation in (scientific) research (Shirk et al., 2012). Although the term citizen science overlaps with crowdsourcing, i.e., soliciting small contributions to a project from a large number of (unknown) people (Bowser and Shanley, 2013, p. 45) – "crowdsourcing for science" (Wiggins and Crowston, 2015); "crowd science" (Scheliga et al., 2016) – they are not synonyms. Citizen science ranges from this "large-scale data collection" (Shirk et al., 2012, p. 26) to the public making research decisions.

ANALYSIS

Defining degrees of participation is a continuing concern within citizen science. No previous study has investigated the levels of participation prevailing in citizen science projects listed in both English-language and German-language directories. This research enhances our understanding of citizen science approaches.

Degrees of Participation

A wide range of projects characterizes the citizen science landscape. To reduce this complexity, researchers have developed typologies. They may focus on goals and physical environment (Wiggins and Crowston, 2012), power (Arnstein, 1969) or community control (Wilderman, 2007). However, the majority of existing typologies categorize citizen science projects according to the degree of participation in (different steps of) the research process (Eitzel et al., 2017, p. 7).

This analysis is based on two of these typologies. Bonney's et al. (2009) model focuses on a researcher's point of view, i.e., the research process, whereas Haklay (2013) emphasizes the use of a contributor's cognitive abilities.

Bonney et al. (2009) (p. 11) identify three degrees of public participation: "Contributory projects" are developed by researchers and citizens who gather data. "Collaborative projects" are basically contributory projects but, in addition, the public may be involved in the further development of project design, data analysis, or dissemination. "Co-created projects" are characterized by collaboration between researchers and public participants at all stages of the research process.

Haklay (2013) (p. 115–116) distinguishes four types of citizen participation: The "crowdsourcing" level does not utilize the cognitive abilities of the volunteers as they carry sensors or donate computing power. On the "distributed intelligence" level, participants should have knowledge and skills to collect, analyze, or interpret data. "Participatory science" means that participants define a problem and collect data, but need expert help in the following steps. "Extreme citizen science" (collaborative science) attempts to include citizens in all decisions and steps of the research process.

Corpus

A corpus of 1,691 citizen science projects from all disciplines was created. In February 2017, data were drawn from 4 English-language project directories [*SciStarter* (830 projects), *US Federal Crowdsourcing and Citizen Science Catalog* (352), *Australian Citizen Science Project Finder* (311, excluding *SciStarter* projects), *Zooniverse* (52)], and 3 German-language directories [*Bürger schaffen Wissen* (84), *Österreich forscht* (38), *Schweiz forscht* (24)]. The English-language directories comprise 1,545 projects compared with a total of 146 projects in German-language directories (Figure 1).

For each project, task descriptions were examined. Whereas, some project directories had predefined lists of activities, others had free text fields for task descriptions. Therefore, only the predominant task derived from task descriptions or project websites was considered in the study. Local initiatives of a larger group (e.g., Fauna Watch) or similar projects (e.g., annual bioblitzes) were treated as individual projects. Project duplicates and finished projects were not removed from the corpus. Activities that are not citizen science per se, e.g., being a subject of research was considered as low-level participation.

RESULTS

The review of 1,691 citizen science projects revealed that members of the public primarily contribute data to citizen science projects. Here, a large number of people complete small tasks. Data collection tasks rank first with data analysis as a distant second. These projects are designed by researchers as the nature of these project directories suggests.

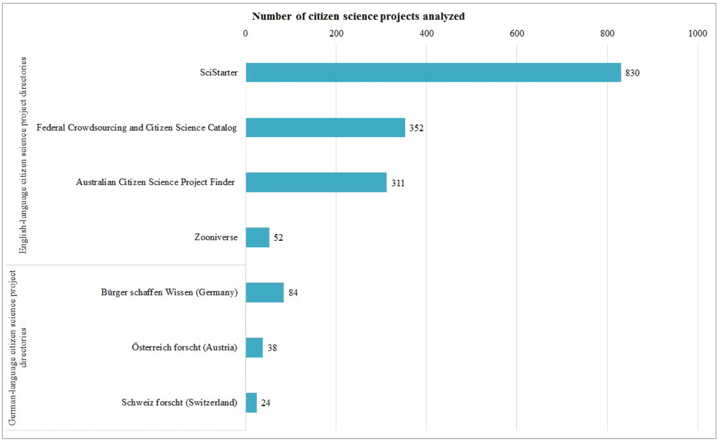

FIGURE 1: Number of citizen science projects analyzed.

There is a clear trend towards contributory projects across all project directories (Figure 2). In total, 1,669 projects (i.e., 98.7% of all projects) are contributory projects compared with collaborative (1.1%) and co-created projects (0.2%). Strikingly, the corpus contained only 4 co-created projects. Compared with the total number of projects, the German-language directories had a higher number of co-created projects (1.4%) compared with the English-language ones (0.1%). Otherwise, there were no significant differences between the German- and English-language directories.

A categorization according to Haklay (2013) gives a similar picture. Across all directories, crowdsourcing and distributed intelligence account for 98.7% of all projects compared with participatory (1.1%) and extreme citizen science projects (0.2%).

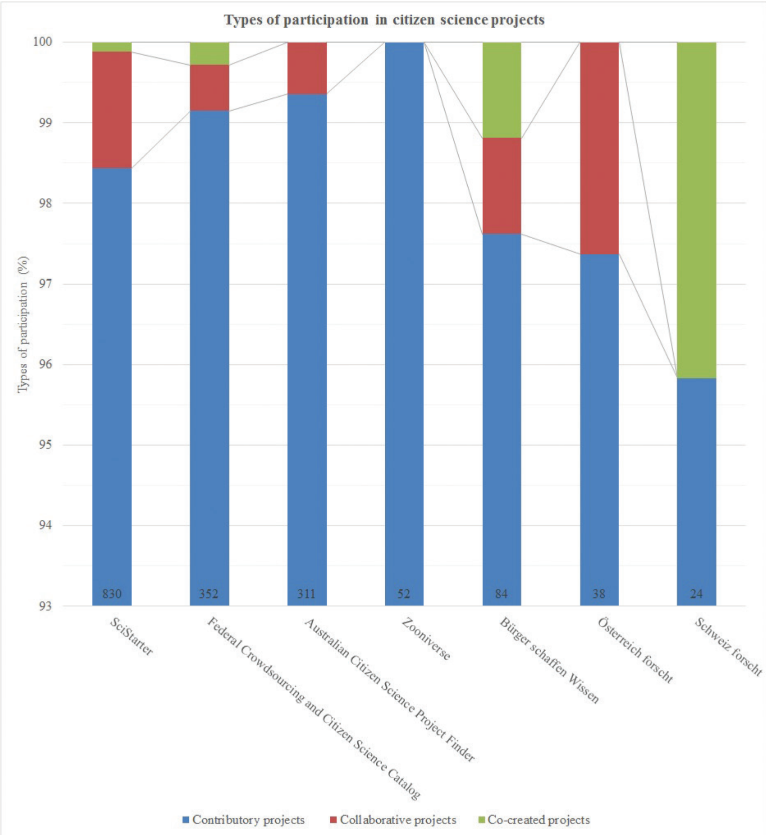

FIGURE 2: Types of participation in citizen science projects

DISCUSSION

Citizen science projects are characterized by different levels of volunteer participation. Strikingly, contributory projects dominate the citizen science landscape. These results match those observed in earlier studies (Wiggins and Crowston, 2012) and confirm the (public's) impression that crowdsourcing [i.e., "crowd science" (Scheliga et al., 2016)] outweighs other forms of participation (Wiggins and Crowston, 2015).

A possible explanation for this might be that participation in citizen science projects is often seen as a means (to achieve a project goal) and not as an end, i.e., giving control to members of a community. Not empowerment, but efficiency seems to be the goal of citizen participation (Lambrou, 2001).

The most obvious finding is that crowdsourcing dominates the citizen science landscape. Crowdsourcing has many forms. It implies that researchers rely on the time and resources of volunteers who support a project. Projects and rules of collaboration are defined by researchers without the participation of citizens. Therefore, citizens are sometimes called honeybees (Fecher, 2014) or data collectors (McEver et al., 2007). However, the crowdsourcing spectrum ranges from effortless tasks to those that require competencies, resources, and time.

Potential sources of bias in the study are non-standardized task descriptions, a bias towards life sciences across all directories (Heinisch, in press) and a focus on project directories that might exclude some forms of participatory research.

Another typology of citizen participation might render a slightly different result. Nevertheless, it can be assumed that the general tendency would be the same.

CONCLUSION

This study provides support for the hypothesis that citizen science projects are dominated by crowdsourcing, thus confirming the impression that citizens primarily collect data for research.

CONFLICT OF INTEREST

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

ACKNOWLEDGMENTS

This research was supported by Austrian Science Fund (FWF): F 60 and Austrian Science Fund (FWF): TCS 40.

Keywords: citizen science, crowdsourcing, levels of participation, volunteer participation, citizen participation, project directories, typology, participatory research

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Let's Talk Science—But How? Considering the Communicational Challenges of Citizen Science

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Participants with diverse professional backgrounds and experiences with Citizen Science (CS) projects discussed in a workshop the challenges in communication they perceive between professional and citizen scientists. Discussants identified four topics they considered particularly important: communication on eye level, communication of data quality, generating synergies between projects, and creating and sustaining participation motivation.

INTRODUCTION

Effective and engaging communication between laypeople and professional scientists is one of the main challenges and key success factors for each citizen science project (see, e.g., Finke, 2014). But what is effective and engaging communication and how can it be established in CS projects? Which obstacles are both professional and lay scientists facing in this respect? The workshop "Let's talk science - but how? Considering the communicational challenges of Citizen Science" addressed these questions in an open format with people from diverse professional backgrounds during the Austrian Citizen Science Conference ÖSCK 2017.

METHOD

The workshop was based on the unconference model, which encourages participants to suggest and choose the specific topics they want to discuss. Instead of having a series of talks and formal discussions between lecturer and audience, the unconference model promotes interaction and conversation between participants (Budd et al., 2015), which makes it particularly suitable for a workshop environment.

In order to identify the topics to be discussed, attendees wrote down and presented the questions and issues they would like to discuss in the workshop. The facilitators collected and clustered these points together with the participants to overarching topics. From those, the plenum selected four which were considered most interesting and discussed them in small groups without facilitation. The workshop concluded with a plenary session in which the groups presented their results and opened them for discussion.

The majority of the twenty workshop participants were professional scientists involved in CS projects in different phases of implementation, coming from different disciplines and institutions ranging from meteorology, zoology or biology to palliative care. There were also communicators and educators dealing with CS attending, as well as a software developer involved in the topic.

RESULTS

The group discussions of the workshop brought forward the following ideas and results:

Communication on Eye Level

Participants emphasised that scientists have to communicate with citizen scientists at eye level, which entails getting to know them, their interests and approaches towards problems. This has to be considered in the project design and process, where ideally citizen scientists can get involved already in the project planning phase, identifying interesting research questions. If necessary, citizen science projects must be flexible and allow for change and adaptation of methods and outline. It is important to accept possible failures and to communicate that those are important and unavoidable elements of research which can also contribute to knowledge.

Another crucial factor is the communication of project results. Participants found that its form has to change and it should be considered as a joint effort of both professional researchers and citizen scientists. Presentation of project result should be tailored to the target group and also communicated via contemporary formats and platforms outside of conventional scientific dissemination, e.g. social media, videos and e-learning platforms or podcasts. Existing channels like school networks can be used as well.

Communication of Data Quality

The collection of irrelevant, false or redundant data is an issue for citizen science projects. To communicate this problem to citizen scientists without discouraging them is challenging for researchers. The discussants suggested a number of possible solutions, which included not saving irrelevant data or handing over data to other projects that might be able to use it. In order to do that, stronger exchange between CS projects would be necessary.

Another critical point is the quality of the collected data. Quality monitoring is already being applied in many projects. Additional training and qualification of citizen scientists to improve data quality is not always feasible, but the collection of personal data from participating citizen scientist could support the analysis, evaluation and explanation of differences in data quality. However, providing personal data is increasingly seen critical and CS projects are facing the challenge of explaining the necessity to collect such data without driving citizen scientists away. Personal meetings between citizen and professional scientists were suggested instead of online communication in this matter to facilitate trust building.

Synergies between Projects

At the moment most citizen science projects operate rather individually, using tools developed specifically for the project. Such insular solutions create parallel structures and redundancies. Therefore, participants discussed a standardisation of instruments and processes accompanied by stronger interconnection of CS projects. It is important to consider the different project characteristics, but structures could be opened up and innovative solutions implemented.

This could be shared data clouds from which individual projects can retrieve data or other organisational forms than the current one of isolated projects. Participants also suggested creating a joint platform for CS projects, in which citizen scientists can commonly work on topics and methods, thus increasing effectiveness, outreach, and impact, and promoting exchange and mutual learning.

Creating and Sustaining Participation Motivation

Participants discussed how it is possible to create and maintain motivation to participate in CS projects. They stressed that the motivation has to start already with the definition of the research question. Citizen scientists have to be involved in this initial process in order to create a research project they are invested in. It is also important to point out to the citizen scientists what they can gain from participating.

Again, meaningful communication on eye level, tailored to the target group is vital to maintain motivation during the entire project. Professional scientists have to consider the different motivations and characteristics of citizen scientists. Multiplicators like local media or associations, archives or libraries can play an important role in the mobilisation and maintenance of participation of citizen scientists, and help to recruit and connect them. Special activities, for example field trips with experts, could further increase the motivation of citizen scientist to contribute to a project.

CONCLUSION

Summing up, the workshop showed that there is a strong need from professional side to engage in a bilateral communication with and gain more information about citizen scientists, but also to exchange experiences between different CS projects. Online communication is not seen as sufficient, additional personal communication creates a stronger commitment. The participants suggested several ideas which can be taken as inspiration for further developments in CS.

Keywords: citizen science, communication, unconference, data quality, synergies, participant motivation

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Storytelling in Citizen Science – Potential for Science Communication and Practical Guideline

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Science communication in citizen science means more than transfer of knowledge or outreach. It involves knowledge exchange and collaboration and needs to bridge the discourses of science and society. Stories can be a powerful tool to communicate the aims or results of a project and thereby motivate participants and create meaningful links between science and society. During the Austrian citizen science Conference 2017 researchers applied a storytelling approach to their presentations following a short storytelling guide that we propose in this paper.

STORYTELLING IN CITIZEN SCIENCE

In citizen science, science communication is integrated in the research process being more than the dissemination of results in a one-way knowledge transfer. From a communication science perspective, citizen science brings together two forms of discourses. Whereas discourse in science is based on logic and should be abstract and results context-free and transferable, discourse in society works with narratives related to a specific context, showing examples and linking to emotions (Hecker, Forthcoming). Stories transport knowledge that can easily be linked to human experience and conceptualised to existing knowledge (Constant and Roberts, 2017). In citizen science, stories can be used for different purposes: motivating participants by linking project's objectives to people's needs, values and expectations; retain participation by frequently telling stories about the project's development, latest findings etc.; telling stories about the project in (social) media; disseminate results.

Stories are not merely chronicles of what researchers found out with the help of participants. They are related to the meanings and underlying problems of a project rather than its abstract knowledge (Hardy, 1968; De Blasio et al., 2009; Collins, 2010). Stories can build a bridge for understanding science and mediate the process of research.

STORYTELLING IN PRACTICE: TELLING STORIES ABOUT THE WEATHER AND YOUR CITIZEN SCIENCE PROJECT

The session on storytelling during the "Austrian Citizen Science Conference 2017"[3] provided an insight to presenters and the audience on the power of narratives. Citizen science project coordinators were trained beforehand on presenting their story during the session.

For example, farmer Franz was presented as the main actor of the citizen science project "Wir schauen auf unsere Wiesen" ("We look at our meadows"),[4] a project where farmers continuously observe their meadows and report back to scientists. The presenters captured the attention of the audience and led them through the research process whilst connecting the research questions to the story of one actor.

Another story was about the European Weather OBserver (EWOB),[5] a public online tool of the European Severe Storms Laboratory to report on severe weather and storm events. This tool—available in 35 languages—provides the possibility to connect the report to social media for immediate sharing.

HOW TO TELL YOUR CITIZEN SCIENCE STORY

Think About Your Audience

Before you start designing your hero and his adventures, take a minute to think about your audience. Think about who should listen to your story. Be as specific as you can: imagine you would like to motivate your neighbour or best friend to participate in your project. Think of the journalist who is not yet convinced of writing about your research. People are individuals with different values, expectations, and experiences. You want to connect with them by sharing the things that have a certain meaning to you—and them. Start a dialogue.

Make a "Good Story"

There are some components to each good and memorable story. Adapt some of these elements to your story.

Every Good Story Has a Hero

The hero can be the scientist, or one of the participants or a formerly unknown insect. Try to make the hero as personal as you can. Your audience wants to identify with him or her.

3 https://www.ages.at/expandinghorizons.
4 http://wiese.biodiversitaetsmonitoring.at.
5 https://www.eswd.eu/ewob.

Every Good Story Starts with a Conflict

The conflict can be a global challenge like climate change or a concern of local communities like air pollution or the loss of a certain butterfly species. Think of why *you* got involved in the research. Get engaged yourself.

Every Good Story Awakes Emotions

Maybe that is the most challenging point—but the most rewarding point, too. Emotions allow us to be fascinated by a story both on the storyteller side and the side of the recipients.

Every Good Story Is Viral and Thus will be Retold

What stories do you retell and why? Think about the hero, the conflict, and the solution of the conflict.

Choose a Functionality

Think about the aim of your story, its functionality. Should your audience learn something from your story? How could that happen? Here are three different possible approaches.

Comparing Experiences

You can tell your story by showing familiar stories allowing for comparison with real-life situations of your audience. People can put themselves into the story and get close to experiencing the hero's dilemma. Lead them and your hero be out of this situation by providing new and alternative options.

Learning As Deputy

Substitute actions can provoke a learning effect. Ideally, with this functionality, we experience unfamiliar and undesired situations. The hero lives the story and we watch him in his learning process, thus learning through simulation.

Contextualization

Contextualising the story, we train in understanding. Here, we search the story for patterns of explanation, e.g., identifying personal aims and needs; understanding the fight to meet these aims; identifying the obstacles that prevent us reaching these aims; discovering options for solutions.

Use a Stylistic Device

This may help you to make the difference between a report and a told story. You can choose one or more of the following examples:

Add a personal experience, e.g., a situation or conversation; use an analogy, i.e., compare an idea or a thing to another quite different thing as in a metaphor. Or imagine what a 9-year-old would say to your story.

Choose a Format

Once you have an idea of your story, take the time to think of your audience again and choose the medium for your story (blog, film, presentation, text, tweet, etc.).

SUMMARY AND CONCLUSION

Storytelling can play a key role in communicating citizen science. Functions can be to share stories thus linking people, connecting scientists and volunteers to the meaning of a project, motivating participants and transferring results to the media, or translating scientific language into engaging narratives. Storytelling needs to engage the self and others and provide a narrative that is both cognitively and emotionally compelling. Presenters at the conference succeeded in captivating the audience and showing their engagement for the projects and their partners.

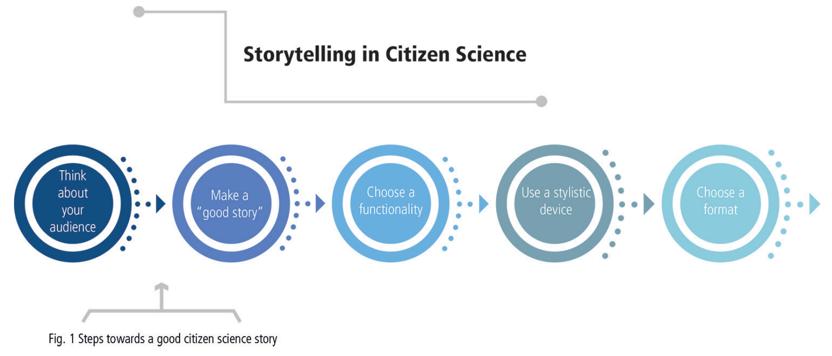

FIGURE 1: Steps towards a good citizen science story.

Keywords: science communication, storytelling, narratives, storytelling guide, science-society interface

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Citizen Science with Schools—Obstacles and Opportunities

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Citizen Science initiatives in cooperation with schools are a very special form of volunteer involvement in research as both, the school setting and the target group, lead to particular benefits and challenges for the project. In the following article we compiled the main advantages of cooperations with schools, grouped the major challenges into categories and developed applicable solution strategies to avoid potential problems in advance. A thorough preparation, proper resource management and constant supervision of the volunteers throughout the entire project seem to be the key issues for a successful project implementation.

INTRODUCTION

Over the past 20 years, citizen science (CS) projects have become increasingly popular and millions of volunteers worldwide are participating in scientific projects covering a broad range of topics (Bonney et al., 2014, 2016). Besides supporting scientists in data gathering, most projects also aim to improve the public perception of science. The integration of CS in school curricula is a long-known approach to increase the scientific literacy of students (Jenkins, 1999), but partnerships with schools are especially challenging as they require a special design and a lot of preparation to achieve both, educational and scientific goals (Gray et al., 2012; Weinstein, 2012; Shah and Martinez, 2016).

This paper summarizes the results of a workshop about CS cooperations between scientists and schools performed during the Austrian CS Conference 2017. Twenty-two participants from different disciplines in research and education (1 teacher, 1 person from administration, 20 scientists, partly with teaching experience; among those 13 from natural, 5 from social, and 2 from human sciences) provided a broad range of professional experience from different perspectives. First, the participants identified advantages and challenges of cooperation projects, next they elaborated solution approaches for a successful CS project implementation.

ADVANTAGES AND CHALLENGES OF CS PROJECTS WITH SCHOOLS

Most of the advantages for schools addressed in the workshop were quite similar to those for individual citizen scientists (Conrad and Hilchey, 2011), like getting insights into the science process or offering access to experts and the latest information. Besides, the break from school routine increases the participant's motivation, thus supporting both the learning process and the scientific output (Table 1). Researchers may additionally benefit from dedicated teachers, the access to a non-biased group with homogeneous knowledge, and the available school equipment. For both schools and scientists, time management was identified as one of the most demanding problems in research-education-cooperations. Inflexible timetables, dense examination schedules, and frequent holiday breaks complicate the coordination with the scientific schedule. Besides the issue of data quality, scientists have to consider additional time for communication, method adaptation, training and supervision, and the preparation of contents adequate for the respective stage of the students (Table 1; Shah and Martinez, 2016).

POTENTIAL SOLUTION STRATEGIES

The main challenges and difficulties encountered in CS partnerships with schools, including their underlying reasons and possible solutions, were categorized into: (1) establishing contact, (2) project suitability, (3) data quality issues, (4) sustainability, and (5) project logistics (Table 2).

Regarding (1) "establishing contacts", it is crucial for scientists to promote the project in a way which distinguishes it from the vast amount of school activity offers and convinces school partners to participate. Personal networks between teachers and scientists were unanimously described as best basis for recruiting participants.

The best approach for solving the challenge of (2)" suitability" is to follow the existing guidelines for developing and implementing CS projects (e.g., Bonney et al., 2009; Shirk et al., 2012; Tweddle et al., 2012; Pocock et al., 2014; www.citizen-science.at). Keeping the research question simple and straightforward, using intelligible methods and clear protocols, all tailor suited for the specific age of the student participants, are necessary preconditions for cooperation with schools (Au et al., 2000, Shah and Martinez, 2016).

Data quality (3) has been identified as one of the greatest problems in CS projects as it affects both the scientific output and the applicability of the results (e.g., Au et al., 2000; Gouveia et al., 2004; Bonney et al., 2009; Dickinson et al., 2010; Conrad and Hilchey, 2011; Weigelhofer and Pölz, 2016). The common tenor of the workshop was that a clear research question and an adequate method are the best basis for good data quality. Therefore, workshop members underlined the importance of training and pre-studies to test the appropriateness of the study design. Joint adjustments of the design by both scientists and school partners were consistently believed to improve data quality and project results in general. Additionally, data validation methods can be performed on three levels (student, teacher, scientist) to enhance data quality.

To reach the aim of (4) "sustainability", it is necessary to leave a lasting positive impression on all participants. There are various strategies to reach this goal—for scientists, individual participants, and social-ecological systems (Shirk et al., 2012). A break from school routine through an innovative approach of learning (e.g., hands-on experience, room for questions and ideas) is the most important aspect for school-aged students. New impulses for teachers and science education can, in the long term, raise scientific literacy by a better imparting of science and the research process.

Most problems of (5) "project logistics" originate from the tight schedule of the school curriculum. Our findings support the statement of Gray et al. (2012) that the major constraints in implementing CS projects in the classroom are the limited resources of scientists, teachers, and students. A joint resource management is the only way to handle these difficulties.

All strategies aim at bridging the gap between the quality requirements for scientific results and the expectations of the participants. Therefore, it seems most important to involve participants (teachers and students) in every stage of the project process to maximize their motivation and learning experience. All activities designed to keep up the commitment of both teachers and their students throughout the entire project process finally led to satisfying project outcomes on all sides.

CONCLUSION

CS partnerships between research institutes and schools can benefit all involved parties—the students, their teachers, and the scientists. In the best case, they serve as enriching, innovative method for science education in the classroom and support the scientific research by gaining meaningful data at the same time. To reach this goal, it is important to be aware of potentially arising difficulties in order to overcome them in advance. The success of CS projects with schools depends to a substantial degree on a sophisticated project design, a thorough preparation of both teachers and students, and the constant guidance throughout the entire project process. Nevertheless, we believe it to be a rewarding experience for all participants.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

AUTHOR CONTRIBUTIONS

All authors agree to be accountable for the content of the work. EF has written most of the text, compiled the tables, and helped with the text, MP has revised text and tables, and GW has helped to sharpen the text.

ACKNOWLEDGMENTS

The conference was funded by the Austrian Agency for Health and Food Safety (AGES), the Austrian Science Fund (FWF), and the platform "Österreich forscht" www.citizen-science.at. We thank the workshop participants Crosina P., Gadermaier G., Hager G., Keilbach M., Kelems-Finan J., Keller E., Kieslinger B., Lippsky L., Matiasch L., Peschl-Wacher C., Pichler-Koban C., Richter A., Schmeller F., Schoissengeyer L., Strähle M., Strausz K., Strobl B., Wagner S., Westenreicher F., Winter S., Winzheim M., and Xaver A. for their valuable contributions.

TABLE 1: Advantages and challenges of Citizen Science Projects with schools.

	Advantages	**Challenges**
For Schools	welcome break from school routine enhancing motivation of teachers and students	selecting appropriate projects
	getting to know science and contacts in science (persons, institutes, mentors, and networks)	bearing in mind that the work is done by voluntarily participating teachers and students
	new input of knowledge	fascinating every student and keeping the engaged ones at it
	working with state-of-the-art methods	coping with additional work due to very high effort in communication and organization
	increasing scientific literacy experiences in scientific inquiry	timing the project work due to the very tight time schedule in schools (the higher the level the tighter)
	adding to school profile	making it practicable during teaching time only (no home work for parents)
	Helping students with career choice	
	providing additional equipment for schools	

	promoting students in self-dependent and self-reliable learning, critical thinking, and discrete problem solving	
For Science	easy access to basic knowledge: thematic introduction done by teacher, necessary training at school	recruiting school partners impeded by overwhelming offers of projects
	providing teacher as support, link, and multiplier	handling the additional work due to very high effort in organization and communication
	demystification of science by hands-on scientific experience and contact to scientists	rigid educational system: problematic compatibility of time-frame for fieldwork and experiments with class schedule
	affecting scientific literacy	obtaining data of high quality
	publicity for institutes and companies	age-based preparing of content, methods, protocols, etc.
	direct transfer of state-of-the-art knowledge	constant guidance and feedback necessary
	recruitment of future scientists	consideration of educational aspect
	increasing the public understanding of science and awareness for current research topics with students acting as multiplier (friends, family)	high number of participants: providing equipment for all involved students requiring intense assistance
	building sustainable networks and agreements	maintaining the motivation of the volunteers (teachers and students)
	availing of basic equipment (laboratory, devices,..)	

TABLE 2: Categorized thematic groups of major challenges, reasons and possible solution strategies.

Topic	Challenges	Reasons	Solutions
establishing contacts and recruitment of project partners	making the project attractive finding and getting in contact with the future cooperation partner finding an appropriate school/ project meeting schools' expectations	high competition too many project offers for schools	describing the project precisely including benefits for schools building networks in advance: at teacher trainings, student lectures, platforms (citizen science,..), Kinderuni, Lange Nacht der Forschung, European School network, in district and municipality administrations considering the importance of personal contacts: establishing and cultivating long- term contacts
suitability of the project	adapting projects for school partners considering limitations of practicability	certain limits for project work in schools (safety, restricted time flexibility,..) tasks need to be age appropriate and methods, adequately adapted integration of the topic to the curriculum needed	keeping research questions clear and simple making the project manageable for students and teachers concerning time and individual dedication (limiting the operating range, no need of time flexibility, providing alternatives,..) guaranteeing safety for students (in laboratory, with outdoor activities..) and ethic integrity (personal data, anonymity, content)

			adapting the methods to student skills and school equipment, especially suitable for projects where a homogenous group of volunteers is needed considering the curriculum in selection of age
data quality	guaranteeing scientifically valuable data, maintaining motivation, and consequently data quality	teachers may be assigned to a project although not interested in the topic project does not meet the interests of the students excessive demands on teachers and students lead to loss of motivation and required accuracy	adapting the research process accordingly: adaptation of sampling, simple, and clear protocols, not too many repetitions (boring) but enough to get routine developing and adjusting the project design jointly—scientists, teachers, and students validating results at different levels (teachers, students, scientists) performing trainings, pre-/pilot-studies, kick-off meetings
sustainability	leaving a lasting impression on participants achieving and maintaining the public awareness (for topic, for science)	not meeting the expectations or interests of the students content and research questions too complicated	enhancing hands-on experience preparing the content age adequately, leaving the students room for own ideas celebrating start and end of project (kick-off meeting, “symposium”) linking the content to daily life of students

	increasing scientific literacy reaching students as multipliers and future scientists	boring routine work dominates project work	offering a role model for career choices showing the application of results and data (product, paper, article,..),
Project logistics	school organisation vs. project requirements project and time management and coordination (when? where? how long? how many? how often?)	course of school year is not in accordance with project length and time table rigid school schedules diverge from necessary flexibility for, e.g., fieldwork or continuous measurements vs. end of school day student numbers vs. available equipment	planning ahead planning together (teacher, students and scientist) estimating and describing amount of work in advance and realistically cooperating with full-time schools

Keywords: citizen science, school cooperation, science education, young citizen science, scientific literacy

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Making Art—Taking Part! Participatory Research and the Development of Artistic Interventions with Young People

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How can Citizen Science be placed in perspective in the context of participatory research and critical art education? After a brief excursion into the concept "research for all," we outline an example of the development of artistic interventions with young people.

"RESEARCH FOR ALL"

The term "Citizen Science" elicits many questions: does it mean that citizens themselves do research? That scientists do research together with them? Or does it mean "research for all," a term that cultural scientist and performance artist Sibylle Peters (2013) introduced in the context of knowledge production encompassing science, art, and society? According to Peters, "research is no longer a privilege of the sciences, but a collective task of all members of society" (ib.: 12). She notes "… that artistic practices can play a decisive role when it comes to research, enabling it to potentially involve all members of society" (ib.: 13). In this perspective, "research for all" is about collaborative knowledge production, empowerment, self-representation, and processes of politicization.

Terms such as "participatory research," "action research," "team research," and "community-based research" identify different approaches to participatory research, in which all share the challenge of engaging in societal contexts and changing them through cooperative research (cf. Reason and Bradbury, 2001; Kindon et al., 2010). Participatory research can be considered as an example of how the boundaries between science and society shift and new forms of knowledge production emerge (Von Unger, 2014: 6). The recurring cycle of action and reflection in the research process produces situational knowledge that can be transferred as experience and viewed as part of the processes of education and politicization.

Approaches to participatory research have already been taken up in the field of critical art education (Mörsch, 2008; Landkammer, 2012) and should be understood as an integral part of a set of methodologies for socio-critical, participatory educational and cultural work (cf. Zobl and Huber, 2016).

ARTISTIC AND CULTURAL INTERVENTIONS WITH YOUNG PEOPLE

How can a collaborative artistic and cultural intervention be developed with young people? In our project "Making Art—Taking Part!" (www.takingpart.at), the students of two classes worked together with artists and the project team to develop artistic and cultural interventions in a public space.[6] Starting from the students' own questions and concerns, the project collaboratively examined and developed intervention formats to produce participatory publics. This process took place over half a year with each class.

In the project process with one class in the city of Salzburg, the issue of "how do we live together?" emerged as a consistent topic in two main focal areas: on the one hand, the production of inequalities, contradictions of coexistence, and demands of the educational and social system, and on the other hand, the future vision of another society. In order to develop the content of the intervention, we discussed in small groups the concepts of protest, language, stereotype, racism, and antiracism (see the glossary in Trafo, (2009)). This led to the development of future visions of what cohabitation could look like: what action strategies and counterstrategies can we find to fight exclusion? Building on the ideas of the students, the project team proposed building a mobile info-wagon to serve as an exchange platform (for ideas, materials, etc.) and to interact with the passersby. The other mediation tools were also based on the students' impulses: a dice installation, a photographic gesture alphabet and instructions for slogans and questions for the picking, as well as buttons to make (cf. Zobl and Huber, 2016). A reflection on the process took place with four students in the form of a paid practicum, resulting in a "digital story" entitled "Art has Many Views".[7]

Throughout the project process, open feedback rounds as well as individual and group interviews with pupils were made to gain a better understanding of their ideas. To return the results of the research process into praxis, a set of educational materials have been developed.

CONCLUSION: POTENTIALS AND CHALLENGES

In this cycle of action and reflection, as well as the collaborative development of interventions, we are concerned with creating a framework in which spaces of agency are opened. The diversity of a participatory research process involving students in the field of critical art education, thus encompasses the questioning of the mechanisms of

6 The project is based on the "Making Art, Making Media, Making Change" science mediation project (www.makingart.at) and the toolbox developed for it (www.w-k.sbg.ac.at/de/zeitgenoessische-kunst-und-kulturproduktion/vermittlung/toolbox.html).

7 See http://www.p-art-icipate.net/cms/kunst-hat-viele-ansichten.

influence that shape social coexistence, the development of visions of change and the experimentation with intervention strategies. If, as mentioned earlier, we understand "research as the collective task of all members of society" (Peters), then artistic and cultural practices and strategies play an important role in it. They have the potential to open up free spaces for experimentation, to shift meanings and to intervene in and even change social contexts.

It is central to understand research and practice as an intertwined, multi-voiced participatory process that occurs within the ambivalences of existing power relations. However, this also presents great challenges: such projects are embedded into powerful institutional systems (schools, universities) and are subject to third-party funding stipulations, which call for results and clear requirements (i.e., with regard to project leadership, team, publications, etc.). These system constraints are somewhat contrary to the desire to create a process-oriented, open-ended approach in a collaborative way of working. A main issue—as often in such projects—has been lack of time, which would have allowed us to work more in-depth and to establish sustained relations.

Research involves a questioning of the concept of knowledge as well as knowledge production itself; from this perspective, it becomes an "activity of participation in a critical sense" (Bippus, 2016). In our project, we have attempted to open up an intermediary space in which ambivalences and questions are addressed, while at the same time foregrounding the self-empowerment of young people. While participatory cultural and research projects are situated in different contexts and have to adhere to their own rules and regulations, we see great potential in a transfer and collaboration between these fields for citizen science.

FIGURE 1: Slogans and questions for the picking, project presentation at NMS Liefering, Salzburg, Austria, July 2015, Photo: Pia Streicher.

FIGURE 2: Dice installation, project presentation at NMS Liefering, Salzburg, Austria, July 2015, Photo: Pia Streicher.

Keywords: participation, artistic and cultural intervention, critical art education, participatory research, research for all

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Digital Activists, Creators, and Artists As Researchers: Exploring Innovative Forms of Participation and Community-Based Governance in Citizen Science

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Inspired by the historic example of Netznetz project – a platform aimed at seeding and supporting net art and net culture for new practices and collaborations in the City of Vienna (2004–2011) – this article outlines alternative quality concepts in citizen science, including the dimensions of participation and self-governance.

QUALITY FOR CITIZEN SCIENCE IN THE FIELD OF HUMANITIES AND DIGITAL CULTURE?

The reflections continue the argument of a preceding article on quality in citizen science with a focus on societal, communicative and relational dimensions (Bartar, 2016). The concept is fragmented, but the author hopes to receive feedback and spur further discussions about citizen science in the humanities, the arts, and digital culture.

Over the last few years, an impressive increase of research interest with focus on multi-disciplinary meta-studies – particularly in the field of Science and Technology Studies (STS) – has taken place. Despite an apparent mainstreaming of citizen science in natural sciences and geography, humanities, transversal projects for example in museums or co-creation in the context of digital culture seem to be areas where citizen science has not been utilized to a larger extent (e.g., Kullenberg and Kasperowski, 2016; Pettibone and Ziegler, 2016). This may be because citizen science is supposed to be shaped by an "institutional corset" and by mechanisms of scientific excellence (Finke, 2014, p. 46 et seq.; Biggs and Karlson, 2011, p. 405 et seq.). To overcome these restrictions collaborative knowledge production needs shared criteria on process and management to enable excellent citizen science in "non-mainstream disciplines".

As this discussion has gained in momentum, the definition of criteria and a quality framework for the evaluation of projects is still ongoing (e.g., Shirk et al., 2012; Bonney et al., 2014). This has become evident in current debates as well as working groups eager to define necessary criteria (see, e.g., Heigl and Dörler, 2015; Kieslinger et al. 2015; ESCA, 2016; Kieslinger et al., 2017; Citizen Science Network Austria, 2017).

In meta-analysis, academic interests focus on data quality and attempt a better differentiation to research models which engage amateurs solely in data gathering. Moreover, many citizen science guidelines focus on science-based standards and on the relevance of citizen engagement in the research process based on a "participation pyramid" (see, e.g., Bürger schaffen Wissen – Die Citizen Science Plattform, 2016, p.16 et seq.).

Some experts have detected a growing interest in civic participation with regard to science and research (see, e.g., Irwin, 1995, 2014, Schneidewind, 2014, Ober, 2015, p. 99 et seq). Scanning a number of prominent reports and guidelines (e.g., Socientize Consortium, 2014; Bürger schaffen Wissen Plattform: Lisa Pettibone et al., 2016; LERU, 2016) the absence of questions concerning experimental concepts of participation leading to innovative community-based peer review and other types of quality assurance, co-design of research scope and programs as well as participatory budgeting as part of collaborative research is evident. This may also reflect institutional resistance against a far-reaching transformation of the science sector and research strategies through further democratization of the field (see, e.g., Schneidewind and Wissel, 2015, p. 5 et seq.) with the help of deliberative communities.

ONE SIZE FITS NONE? – PARTICIPATION IN COLLABORATIVE-KNOWLEDGE PRODUCTION

The arts, digital culture, and the maker movement have become important laboratories for co-creation and the evolution of alternative forms of research (such as artistic research and holistic design strategies). These approaches towards knowledge production challenge a paradigmatic view in which "knowledge can be carefully defined and controlled" (Cole and Knowles, 2008, p.60) and understand humans as "sentient creatures, who live in a qualitative world" (Eisner, 1993, p.6 quoted in Cole and Knowles, 2008). This theorem also highlights empathy and conflict as other parameters for quality in collaborative knowledge making and excellence in output: The project Netznetz was an early experiment in digital culture comprising strategies of consensus-making and participatory budgeting with public funding. The project aimed to innovate assessment and funding schemes for digital art in Vienna. Corresponding to principles of participatory action research and related community-based research (CBPR, see, e.g., Edwards et al., 2008; Bradbury, 2015) Netznetz involved a local community in many aspects of the participatory experiment. The entity was dynamic and self-defined by the community and also included formally trained researchers with backgrounds in cultural sciences. Netznetz.net started in 2004 after a three-day convention (see, e.g., the Netznetz online repository; OTS press release, 2006). A community of digital artists, activists from the open source movement, digital creators and researchers discussed new practices and models of collaboration in the context of future digital city. Another objective was to offer access to new techniques and strategies in horizontal working situations. Activists experimented above all with a software-based funding community game called "Mana" to foster self-governance and non-hegemonic ways to distribute funding. The network-enabled performance was linked to game theory and abandoned **a** compliant set of agreed quality criteria to select projects (Bartar, 2017, expert interview wit Stefan Lutschinger). After several periods of project support, the City of Vienna stopped funding due to interest conflicts in the community: The final project report revealed a "wicked problem" concerning **beneficiaries** also taking over the role of funding bodies (Katzmair and Gulas, 2009). Partially unfulfilled expectations such as struggling concerning the institutional setting were caused by the interplay of an open end approach concerning content and process and the formation of communities of interest to gain **resources** (also **discussed as "bandbus phenomenon"**, ibid.)

CONCLUDING REMARKS

Considering the above aspects and experiences from the Netznetz project, the analysis (and evaluation) of collaborative knowledge production needs to address processual aspects and relational dimensions among stakeholders. To enhance the spectrum of citizen engagement in citizen science, modes of participation could enable "thinking in alternatives" leaving institutional conventions behind by taking risks of experimental approaches. Currently – and about ten years after the Netznetz participatory experiment – European projects such as Empatia or D-Cent foster and implement strategies in collaborative policymaking and/or participatory budgeting based on open source tools addressing this problems. Another project to mention is Extreme Citizen Science. ExCiteS is a bottom-up initiative at University College London (UCL) that allows citizens to design devices and start knowledge creation processes with a broad network of people including university experts. A later review of these projects will facilitate new insights about how to better design and manage collaborative knowledge production based on processes of participation.

Keywords: citizen science, collaborative knowledge production, humanities, digital culture, self-governance, participation, quality, challenges to and limits of transdisciplinary collaboration

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Urban Archaeology (Stadtarchäologie Wien), Science and Volunteers—A Challenge

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The basic function and the main purpose of the "Stadtarchäologie Wien" are researching the archaeological history of the Austrian capital by excavation, scientific interpretation of the findings, and competent communication of the results.

THE BEGINNING OF THE PROJECT

Communication became a main aspect. This led to the creation of two new projects in 1995: for juniors the "Intitiative Juniorarchäologie" (Strohschneider-Laue, 1998a) with 2 aluminium cases as portable museums in order to make history tangible by using original findings, and for seniors the "Initiative Seniorarchäologie". The first concept for the latter was created in 1994 and then further developed in 1995. It was necessary to organise a structure including forms, such as statistics for acquiring master data and information about the interests of the volunteers, and it was also necessary to organise suitable locations. It was important to create a structure in Vienna without membership or obligation for the people interested. Excavations at Judenplatz resulted in the enormous amount of 160 boxes containing 80,000 ceramic fragments and about 750 kgs of animal bones. The help of volunteers became necessary for dealing with such an amount of findings. In 1997, senior archaeologists volunteered for approximately 5,200 h (Helgert, 1998) in dealing with these findings.

From 1995 until 1997, the first courses for dealing with findings were held in the Bezirksmuseum Landstrasse, Sechskrügelgasse (Kleinecke, 1998). From 1997 until spring 1999, the Berufsschule Mollardgasse offered a facility for cleaning, labelling, and sorting findings as well as preparing them for restoration. Since 1996, co-operation with the Volkshochschule Meidling has existed. There we offer lectures and excursions under the title "Seniorarchäologie" in exchange for a free room for working on ceramic findings (Strohschneider-Laue, 1998b). From 2012 on, a room for ceramic findings has been adapted on the premises of the Stadtarchäologie Wien at the Obere Augartenstrasse (see illustration). In the meantime, the number of volunteers had increased to more than 420 people. The task areas have also been adapted several times to meet the new challenges. In addition to the preparation work for restoration and an initial recording of the ceramic findings, new activities, such as taking pictures of the findings, translations of foreign-language literature, and work for the international conference Cultural Heritage and New Technologies CHNT at the Rathaus Wien have been included. Thus, 2883 h of work, i.e., 360 working days, have been put in by senior archaeologists in the year 2016 (see Fig. 1 and Tab. 1 for hours worked).

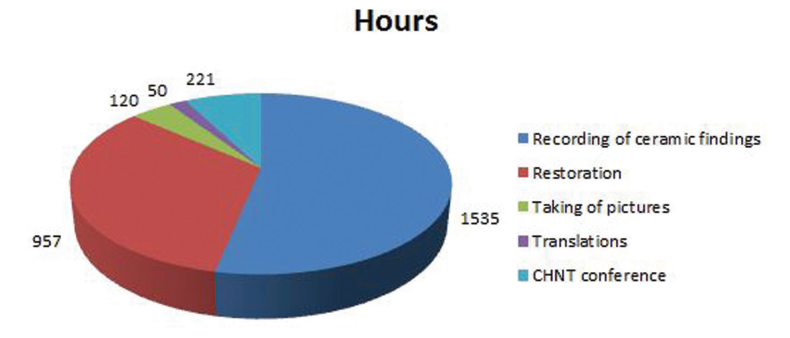

FIGURE 1: Working hours, Copyright Stadtarchäologie Wien.

TABLE 1: Working hours.

Activity	**Hours**
Recording of ceramic findings	1535
Restoration	957
Taking of pictures	120
Translations	50
CHNT conference	221

METHODS AND BENEFITS

How far the necessary amount of supervision is compared with the support gained? In 2016, as an initial training 10 lectures were held by staff of the Stadtarchäologie Wien in front of 20–25 persons at the VHS Meidling. In 2016, the news bulletin “Lorbeer” was sent to 424 members. This year, “Lorbeer” was replaced by a new website, http://stadtarchaeologie.at opening up totally new ways to inform and communicate with interested inhabitants of Vienna. Besides these various approaching lines of information, the process of working with and personally training each and every volunteer is of the essence. The support gained is enormous, but so is the amount of personal supervision. This amount varies, depending on the situation, from two or three staff members (in 2016 approximately 1760 h of supervision) to more than five persons. Normally, the volunteer-working hours are between 9:00 a.m. and 1:00 p.m. During the months of summer 2017—and this is a good example for the flexibility and, if needed, adaptability of this whole volunteer-system in our department—this interval was expanded (9:00 a.m.–4:00 p.m.) and due to the larger group of involved staff members, the amount of supervision-time rose from around 20 h a week to approximately 120 h a week.

Another bonus is the social aspect of such a project. The common interest in archaeology and the joint commitment to an important task within the Stadtarchäologie Wien create a bond and provide the satisfaction of making an important contribution.

DISCUSSION

Again and again the question arises, whether it would be feasible to have volunteers working at archaeological sites. In Vienna, excavations are made at building sites. Here, you will find a vast discrepancy between the idealistic views on archaeology of the public and the reality of everyday routine at sites. Instead of an adventurous search for treasures, archaeologists are confronted with strict safety instructions, firm decisions of the builder, and a tight building plan under high-time pressure. Therefore, physical fitness and personal responsibilities are required on one hand, as well as expert knowledge on the other hand. At a research dig, however, the situation is different. Since 1994, there have been campaigns with senior archaeologists from time to time at Unterlaa near the Johanneskirche at the foot of the Johannesberg. For these campaigns, the Stadtarchäologie Wien was able to take out a third-party insurance policy. However, such an insurance would not be possible at building sites because of the cost factor and the lack of offers. Therefore, the project that remained was the repair workshop at VHS Meidling and alternatively at the premises of the Stadtarchäologie Wien.

CONCLUSION

Stadtarchäologie Wien has undergone a long and profound development and was able to apply the experiences gained. Such learning processes led to changes in time management. Task areas were clearly defined and structured support processes were created in order to meet the demands of certain age groups or interest groups, such as hobby archaeologists and collectors. Thus, by optimizing processes it was possible to create a suitable configuration for Vienna, which is useful for science as well as including an interested public. It is very important to permanently adapt and improve details. This depends largely on the persons involved. On the one hand, motivation and continued support has to be provided by the archaeologists involved and on the other hand, understanding and engagement on the volunteers' part is necessary. Also their abilities and physical fitness have to be taken into consideration as well as the permanently changing task areas caused by the circumstances.

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Transcriba—A Citizen Science Project Supporting the Transcription of Manuscripts through Gamification

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INTRODUCTION

The rise of digital technology during the last years has created a lot of opportunities for science and science projects to involve the public in their research (Finke, 2014). The humanities also host an increasing number of citizen science and/or crowdsourcing projects on a national as well as international level (Oswald and Smolarski, 2016). At the same time and in line with the keywords, "Open Access," "Open Data," and "Open Science," humanities struggle to present their research data and results to the interested public.

True to the motto "Science/Knowledge for everyone," this includes not only free access to sources and cultural assets, but also free access to scientific knowledge and methods. The terms *citizen science* and *crowdsourcing* refer to more than just disseminating scientific results for the public. Open access sciences aim towards integrating interested and dedicated citizens into the scientific process and the generation of new knowledge. Thus, the visibility of science projects is increased in the public.

Transcriba[8] is one of such projects. The project's focus is the community-supported elicitation and transcription of handwritten texts found in archives and libraries. Until now, such texts have been processed by domain experts or scientists. Given the huge number of handwritten documents and their manifold usage scenarios for science as well as for society, the inclusion of interested citizens for exploitation, transcription, and scientific discourse is a very promising idea. For a long time, this type of inclusion has been realized with volunteers, which enabled scientists to start working with this huge data pool. Adequate infrastructures and communication methods are missing to activate a larger non-scientific public and raise their interest in historical documents.

8 http://www.transcriba.de.

GOALS

The Transcriba project aims to develop suitable gamification strategies and gaming elements that raise the interest and readiness for participating in the transcription work and, at the same time, raise the quality level of the transcription. Proven methods were taken from the gamification research domain, such as lists of precedence, feedback systems, or quests. These methods enable an on-the-fly collaboration among players to successfully and efficiently solve the provided tasks in a group. Using this approach, we expect an avalanche effect among users of such systems which increases their sympathy for the transcription system. The success of the gamification approach within the humanities was successfully proven for tagging art pieces (Weinhold, 2016) and for transcribing hand-written documents (Moyle et al., 2011).

The gamification elements are mostly targeted to reward active users with game points, although the actual process of transcribing documents is not yet part of gaming ideas. This project aims to develop suitable gaming concepts, not only by rewarding users with virtual game points, but also by including quest-oriented gaming concepts when working with historical documents. Quality control based upon rules to avoid misuse is an important part of this paper's approach.

PROJECT STATUS

The current version of Transcriba was developed by Alexander Noack in the scope of his bachelor thesis (Noack, 2017). It consists of multiple decoupled applications interacting with each other. The first one is the central server application, which holds the user and manuscript data and controls access to it. It also takes care of background tasks like giving a reward to users. The second component is the client application, which provides an interface for the transcription tool to the user and enables him to explore manuscript images. Even though the default client is browser-based, other clients which are capable of handling simple HTTP requests like native smartphone apps may be added.

Organizations which want to make their manuscript images available to the public can add a certain interface to their server. This enables the central server application to communicate with that server to exchange manuscript data. Transcriba allows importing and presenting manuscript data and exporting the transcription as a TEI-encoded (Text Encoding Initiative[9]) file, which is an established international XML format in the field of digital humanities. The TEI specification allows a broad spectrum of XML tags to qualify text elements like pages, headings, paragraphs, marginal notes, and a lot more. Thus, it can represent manuscript data. The transcription tool was designed to

9 http://www.tei-c.org.

hide the complexity of the TEI standard by providing a visual self-explanatory editor interface with a preview function.

The organization which provided the manuscript image to the platform is not only able to retrieve the transcription data, but can also track the progress on it. Currently, the gamification part of Transcriba provides basic functionalities like awarding points based on a simple scoring model. A user publishing changes on a transcription will be rewarded or penalized based on a majority vote given by a part of the crowd reviewing those changes. Within the client application, users are encouraged to participate in votes and reviews by also rewarding them for that task.

OUTLOOK

The first prototype was tested together with students and other interested people. Besides many bug-fixes, a lot of new ideas were brought into the project. Functions to merge manuscripts into collections to distribute them, are missing on the current platform. Complex pieces will be transcribed as well. This has been addressed in the software architecture, and only the implementation is missing. The import function and API is implemented and working well, but it needs to be implemented by each partner for their projects. This can be a show-stopper for the owners of smaller collections which will be addressed by a reference implementation. For a long, voluntary work period the gamification concept will be improved and enhanced. In future releases, the process of transcribing documents will get an enhanced structure (collection of meta-data, decomposition and transcription).

Finally, advertising the project to different institutions with many historical and not edited documents is very important to further develop the project and to have new, different test scenarios.

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TSN Trusted Spotter Network Austria—Targeted Human Assessment in Crowd Sourcing

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The Trusted Spotter Network Austria TSN was established in 2009 as a collaboration between Zentralanstalt für Meteorologie und Geodynamik ZAMG, Skywarn Austria and the European Severe Storms Laboratory ESSL. Since then, so called Trusted Spotters (voluntary laymen like weather enthusiasts or storm chasers) send reports about severe weather events and their respective damages to the European Severe Weather Database ESWD which is available to the operational forecaster in real time. The Trusted Spotter is specifically trained by ZAMG and the reported observations are subject to thorough quality management at ESSL. This crowd sourcing concept was referred as most advanced and best practice by the European Meteorological Society in 2015.

INTRODUCTION AND MOTIVATION

Real-time observations of weather hazards are essential for impact-based forecasts and warnings. While automatic weather stations measure standard meteorological parameters with high accuracy and at high-temporal resolution, they cannot directly tell us about the impact of a particular weather phenomenon on the local environment and human activities. Examples of phenomena which have an immediate ad impact are flash floods, damaging wind gusts, hail, black ice, rime, and others. Despite the help of state-of-the-art instruments, not even precipitation phase changes between rain, snow, freezing rain, or ice pellets can reliably be captured without a targeted assessment of human observers, yet. The trend to automatize the weather station networks and to cut the number of official weather observers has left a void of "ground truth" information. However, ground observations provide essential feedback to meteorologists to issue and adapt impact-based forecasts and warnings, and also to improve weather-related risk assessment. In Austria, amateur meteorologists like spotters or storm chasers are organized within associations, e.g., Skywarn Austria. The necessary infrastructure was developed to make their storm reports available in real-time to forecasters at Austria's national weather service (Zentralanstalt für Meteorologie und Geodynamik, ZAMG) and to feed them into the European Severe Weather Database (ESWD), operated by the European Severe Storms Laboratory (ESSL). The efforts to combine training, quality management, and report type standardization resulted in substantial quality improvements of severe weather reports in Austria. This collaboration between Skywarn Austria, ZAMG, and ESSL is thus beneficial to all involved parties and is advocated as best practice model for other European countries (http://www.emetsoc.org/resources/best-practice/outreach-and-communication/#1445334485874-ecf2772a-7af9).

TRUSTED SPOTTERS—SPECIALISTS AMONG STORM SPOTTERS AND CHASERS

So-called "spotters" voluntarily report severe weather and accompanied damages to ZAMG forecasters and the ESWD. Their reports satisfy high quality demands and are provided according to strict guidelines. Thus, the ZAMG offers an extensive educational program to enable spotters for the successful accomplishment of these requirements. The ESWD provides the interface between Trusted Spotters and forecasters, enabling meteorologists to rely on information in real-time. Formerly, reports were submitted to ZAMG with limited usability for the forecaster. To improve the reporting quality, ESSL was brought into the collaboration, also to integrate a pre-existing European quality control system standard. Therefore, the Trusted Spotter Network Austria was established to serve the purpose of a reliable ground-impact observation network between spotters, operational forecasters, and scientists.

FULL SUPPORT FROM ZAMG

After the institutionalization of TSN, the reliability of the received information improved significantly. To sustain these high quality demands, ZAMG offers a comprehensive training program, which seems to be the most sophisticated among European national weather services. The first component consists of an individual training, e.g. job-shadowing, at ZAMG. This standardized procedure is provided by forecasters of every regional center of ZAMG. Here, the training focuses on the comprehension and the application of the respective event types according to ESWD criteria. The second component involves up to three joint annual workshops at different Austrian locations. In addition to presentations from spotters and scientists, all participants thoroughly discuss meteorological phenomena as well as case studies. Both components are mandatory for a full license and must be completed successfully at least once by each individual TSN aspirant. All TSN members are invited to attend to workshops annually.

AN EUROPEAN STANDARD FOR SEVERE WEATHER REPORTS: THE EUROPEAN SEVERE WEATHER

Database

A basic motivation for establishing the TSN was the integration of Austrian spotter information within the European-wide ESWD database. For the benefit of international comparability, the reports have to follow a standardized data format as well as parameter guidelines (see also https://www.eswd.eu/docs/ESWD_criteria_en.pdf). ESWD, provided by ESSL, is a database of all- seasonal severe weather- and damage reports in the greater European region. The ESWD data base is also open to public reports including date, location, type of event and additional information (e.g. intensity and type of damage). Because of the individual training efforts, observations from a Trusted Spotter within the ESWD will receive a higher quality label than those from the general public. Different levels of quality criteria maintain those efforts:

A report from the general public will be marked with QC0, "as received", without any preliminary quality control. A QC0+ report is usually given by a member of a national spotter organization (e.g., Skywarn) and categorized with "plausibility check passed". A "confirmed report" will receive QC1, usually resulting from thorough quality control by ESSL and a trusted spotter, respectively. An event is "fully verified" at QC2, mostly representing a scientific case study. To accomplish these standards for ESWD reports, a trusted spotter is only allowed to give information obtained from personal observation. Forwarded information, even from other trusted spotters should be excluded. Reports from "trusted spotters" are therefore accepted by ESWD with QC1 clearance. Further, a "trusted spotter" is supported by real-time weather information from ZAMG, accessible via internet. Thus, the spotters of the TSN are provided with crucial weather information during their observations. TSN reports within the ESWD data base can be filtered according to time and quality clearance, further they can be filed to the database independently from the time of occurrence of the event (www.eswd.eu). Meanwhile, ESWD reports are used for scientific analysis as a European reference standard.

NATIONAL AND INTERNATIONAL BENEFITS OF THE ONGOING COLLABORATION TSN

Currently, ESWD criteria are valid for all reports given either from the general public or trained observers, not only in Austria but also across Europe. Thus, operational forecasters are able to conduct adjustments to warnings, and also use substantially improved reliable and trusted information about severe weather and consecutive damages for the communication with, e.g., civil authorities and the public. Given the severity and societal impact of severe weather, joint case studies in cooperation with all partners can be released to the public without significant delay.

Keywords: standardization of severe weather- and damage reports, Trusted Spotter Network Austria TSN, citizen science

Monitoring Urban Tree Growth via Citizen Science: First Results with the CITREE Dendrometer System

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INTRODUCTION

Urban trees fulfil manifold functions (e.g., Sung, 2013; Ow and Ghosh, 2017), but they are also exposed to high stress intensities. In cities, drought and heat are generally more intense (e.g., Litvak et al., 2012; Gillner et al., 2013, 2014; Savi et al., 2015; Mohajerani et al., 2017), and other stress factors burden trees in parallel (e.g., Day et al., 2010; Helama et al., 2012; Gillner et al., 2013; Meineke et al., 2013; Asawa et al., 2017). Therefore, trees in cities are "living laboratories" (Farrell et al., 2015) and growth data thus enable analysis of stress mechanisms and responses as well as estimations of expected future changes.

CITREE is a citizen science (e.g., Theobald et al., 2015; Kullenberg and Kasperowski, 2016) project, which uses a crowdsourcing system (Silvertown, 2009; Dickinson et al., 2010; Miller-Rushing et al., 2012; Tulloch et al., 2013; Bonney et al., 2014; Danielsen et al., 2014; Alender, 2016; Shupe, 2017) to monitor the growth of urban trees. The system is based on band dendrometers (e.g., Bormann and Kozlowski, 1962; Palmer and Ogden, 1983; Cattelino et al., 1986; Anemaet and Middleton, 2013), which enable a low-cost monitoring of urban trees by help of citizens. Citizens read out the dendrometers via a webpage after scanning the CITREE QR-code on the tree, and data is recorded and stored in a database (www.citree.net).

Here, we present results of the test phase, which aimed at (i) the development of the dendrometer system, (ii) the development of the database and webpage for data collection and presentation, and (iii) the test of developed systems under urban conditions.

MATERIALS AND METHODS

Development of the CITREE Dendrometer and Installation System

The CITREE dendrometer system is based on the "DB20 stem increment sensor" dendrometer (EMS, Czech Republic), which was modified as follows: the scale was simplified (removal of the nonius) and set from 10 to 90 mm (to avoid uncertainty about mm/cm unit), and the labelling was enlarged (improved readability). Loops to fix the overarching band ends were added. Tags including the tree number, a QR code for direct access to the website, and the CITREE logo were designed. The dendrometer system is typically mounted between 140 and 190 cm height and the tags ca. 20 cm above. An installation guideline and table for information to be collected during installation has been prepared.

Development of the CITREE Database and Webpage

The CITREE database can be accessed by various devices, including smartphone, tablet, or PC via a responsive webpage. The webpage (www.citree.net) displays a map showing the cities involved (Figure 1). Clicking on the city opens a new map showing all trees installed, and clicking on the tree of interest will lead the user to a separate site showing a photo of the tree, the tree number, and the main information (species, height, location) as well as a field for input of dendrometer readings. Only meaningful values can be sent to the database. After submitting the data, the growth curve at the end of the page is refreshed. By using dendrometer readings, the diameter is calculated as:

$$D = (C_{init} - D_{init} + D_{act}) / \pi \qquad (1)$$

where C_{init} is the initial circumference at the installation height, D_{init} is the initial dendrometer value, and D_{act} is the actual value read and submitted by the citizen.

Test of CITREE under Urban Conditions

The system has been tested in Innsbruck, whereby trees representing different urban situations were selected. CITREE was installed on overall 15 trees at five downtown places and on 5 trees in the Botanical Garden of Innsbruck (Table 1). Installations were made in spring 2017 and then inspected weekly. Further, dendrometers were installed in Ghent, Belgium and Trins, Austria (data not shown).

RESULTS AND DISCUSSION

The CITREE system is easy to install within ca. 20 min. For big trees (circumference >1 m) installation requires two persons. All tested mobile QR code readers quickly recognized the QR code. Installed systems were running throughout the 2017 vegetation period. In most cases, dendrometer values decreased in the first two weeks, as the dendrometer spring further tautened the band (Figure 1). It was possible to perform accurate and reproducible readings (even 0.1 mm could be estimated by co-workers), and readability was sufficient both under full sunlight (minor dazzle effect although dendrometers are made of high-grade steel) and at dawn/sunset (sufficient contrast of scale). Readings and data input took few minutes. Besides involved students or co-workers of the project, also interested citizens contributed with readings, whereby activities varied across sites (Table 1). No difference in quality of measurements (Butt et al., 2013; Roman et al., 2017) between co-workers and citizens was observed. First announcements of the CITREE project in local newspapers (www.uibk.ac.at/public-relations/medien/wissenswert/wissenswert-juni-2017.pdf; www.krone.at/tirol/dem-baumwachstum-auf-der-spur-uni-projekt-story-583460) probably helped to increase the number of readings and the visibility of the project.

Vandalism appeared to be a major problem. During the test period, dendrometers and/or tags had to be replaced in 8 cases and 4 times repair was necessary. Interestingly, systems at permanently frequented places were less affected than at promenade alleys (Table 1). Replacement or repair of the system could be done in a short time, but caused breaks in the resulting growth curve, which had to be corrected in the database. For future use of the CITREE system, it will be important to consider the possibility of vandalism, and thus to carefully choose the sites of installation.

Results indicate that CITREE can be used to build a bridge between citizens and their trees as citizens can participate in tree monitoring and observe and gain knowledge on how their trees are growing. Based on the outcome of the test phase, it is planned to install CITREE systems in several cities during the next years and to establish cooperation with public authorities and schools. Like other approaches (e.g., Galloway et al., 2006; Ingwell and Preisser, 2010; Pocock and Evans, 2014; Delbart et al., 2015; Pocock et al., 2017), CITREE may be a useful and advantageous scientific tool in urban tree ecology.

FUNDING

This project was funded by Bundesministerium für Wissenschaft, Forschung und Wirtschaft, Austria in the frame of the Top Citizen Science Initiative.

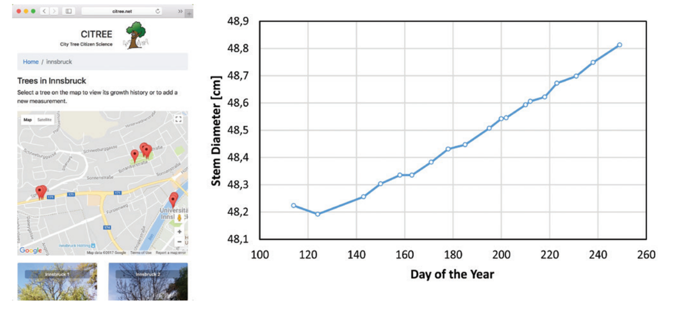

FIGURE 1: CITREE webpage (left) and example of growth data (*Platanus acerifolia*, tree no. 18) collected in summer 2017 (right).

TABLE 1: Dendrometer systems installed in Innsbruck.

Location	Species	n per species	replace-ments	repairs	read-ings
Kranebitter Allee[1]	*Platanus acerifolia*	3	0	0	47
Adolf-Pichler-Platz[2]	*Pinus sylvestris*	3	0	1	59
Innrain[2]	*Aesculus hippocastanum*	3	0	0	63
Herzog-Siegmund-Ufer[3*]	*Tilia platyphyllos*	3	6	0	33
Franz-Gschnitzer-Promenade[3]	*Platanus acerifolia*	3	2	3	52
Botanical Garden	*Betula pendula, Betula utilis, Davidia involucrata, Sequoiadendron giganteum, Sorbus intermedia*	1	0	0	87

Location, species, number of equipped trees, replacements, repairs, and readings (2017-04-29 to 2017-08-31) are given. [1]less and [2]highly frequented places, [3]promenade alleys. [*]At Herzog-Siegmund-Ufer, the entire system was repeatedly removed for unknown reasons so that replacement was stopped after the loss of overall four system sets.

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Challenges of Citizen Science in Forest Fire Research

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Austria is an Alpine Central European country with a forest cover of 47% mainly dominated by coniferous tree species. Forest fires in Austria play no major role so far compared to the damages and related costs of other natural disturbances (e.g., storm, bark beetles). However, they are likely to become more important as expected impacts of climate change, socioeconomic changes, and the demands for the provision of ecosystem services are supposed to evolve (Badeck et al., 2003; Barriopedro et al., 2011; Zumbrunnen et al., 2012; Arndt et al., 2013; Seidl et al., 2014; Valese et al., 2014). Regional climate models suggest an increase in temperature and a reduction of precipitation in summer and autumn, especially in the south and east of Austria, which would likely lead to more frequent forest fires (Matulla et al., 2004; Dankers and Hiederer, 2008; Lautenschlager et al., 2009; Fischer and Schär, 2010).

On average, 200 forest fires are observed in Austria per year, mostly below one hectare in size. The numbers vary along with intensity and duration of drought periods during the year. A total of 85% of all fires are caused by humans, 15% are the result of lightning activity (Müller et al., 2013). Analysis on the occurrence, distribution, causes, and characteristics of forest fires were accomplished (Vacik et al., 2011) and accompanied by case studies, fuel investigations, and fire behavior modeling (Arpaci et al., 2011, 2013; Müller et al., 2013).

The sound basis for the research activities is the documentation of forest fires in Austria. Until now more than 4500 fires were recorded. In 2013, a forest fire database and public accessible web-based Geographic Information System (Web-GIS) were developed to standardize the acquisition of forest fire data and to improve the upload of fire events (Vacik and Müller, 2013). Statistics, charts, and maps allow visualizing the fire events *via* the Web-GIS application. It is possible to draw a map or a bar chart of the spatial and temporal distribution of forest fires in Austria for different time steps interactively (Figure 1). Citizen scientists can support the documentation of forest fires through the online platform. When reporting a fire, the mandatory information includes the type of fire (forest fire, grass fire, burning tree, etc.), the exact date and the location. It is possible to record additional information like the time of fire outbreak, the duration, the burned area, tree species, vegetation, and the fire causes. Photos and videos of the forest fire can be uploaded as well.

All reported fires are checked for validity and completeness in the internal database by the administrator and are automatically blended with existing GIS-layers to obtain additional information (altitude, exposition, slope, size of forest area, forest eco region, municipality, etc.).

The topic of forest fires gets high attention from the media during the fire season in early spring and summer. The interest in forest fire documentation is also generally high (insurances, fire brigades, municipalities) and many potential citizen scientists can be theoretically motivated to support the documentation (300,000 members of fires brigades, 250, 000 forest owners). As nearly, every municipality has its own fire brigade, a comprehensive and centralized forest fire documentation for Austria should be possible.

However, the requirements for the data quality are high and some legal aspects are still unsolved (e.g., the storage of forest fire images). Currently, there are only few volunteers who support the data collection, although active public relation is done by running an up to date forest fire blog (http://fireblog.boku.ac.at) and producing press releases. Unfortunately, the user behavior regarding the documentation is almost unknown. It is known that the personal interest in active participation in scientific activities may increase if the topic is relevant for citizens or is mediated in an interactive way (Bonney et al., 2009). Currently, there are no levels of participation considered, as pure data supply is the main involvement and no collaborative exchange during all scientific steps is intended (Shirk et al., 2012). Also the efficiency of the current online Web-GIS application is not well understood. The citizen science aspect is composed as simple VGI-activity (Volunteered Geographic Information) and no PGIS (Participatory Geographic Information System) is implemented. Therefore, the potential participation in scientific activities and the active design of the research is limited (Haklay, 2013). In this context, workshops and trainings with forest brigades, authorities, or schools may help to sensitize potential citizen scientists with an online-tutorial or a practical handbook. The release of a forest fire app for smartphones may increase the collaboration additionally; however, the long-term maintenance of such an application is a challenge on its own.

The risk of deficiency reports and wittingly false reports is an important aspect in citizen science as well. Regarding the data quality it is probably necessary to find a compromise between public involvement/educational work and the collection of reliable data (Dickinson et al., 2010, Chase and Levine, 2016). In this context, it has to be discussed if the registration and personification of users—which is currently not done—is useful or even contradicts the endeavors to document forest fires.

A process-oriented monitoring may help to further increase the number of active citizen scientists and improve the data quality provided (Conrad and Hilchey, 2010).

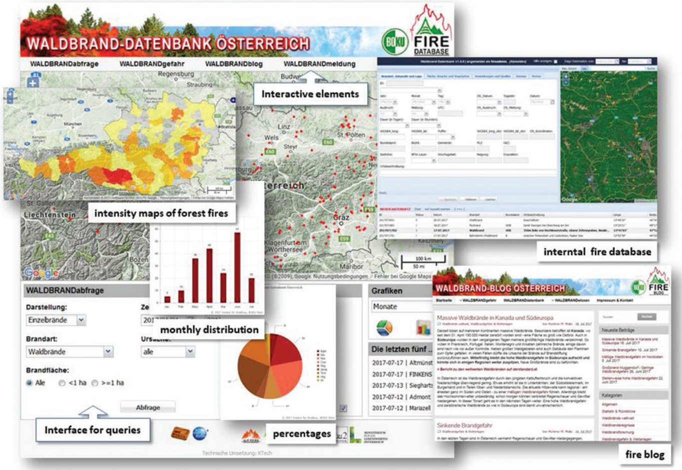

FIGURE 1: Screenshot of the interfaces of the external and internal fire database and the blog.

Keywords: forest fire, database, Web-GIS, participation

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The Database of Fungi in Austria—A Citizen Science Project and Recent Applications for Biodiversity Research and Conservation

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INTRODUCTION

The Austrian Mycological Society (ÖMG; http://www.univie.ac.at/oemykges/) is a link between the limited number of professional mycologists employed in Austria and a larger community of citizen scientists. The Database of Fungi in Austria, a scientifically curated database of fungal records relies heavily on contributions by amateur mycologists, many of them with highly advanced knowledge and identification skills. The database currently holds more than 500k records of more than 8,000 fungal taxa from almost 15k different locations. Species occurrence data are an essential resource for biodiversity research and conservation, exemplary studies, and conservation efforts based on these data will be presented.

The New Index and Red List of Macrofungi in Austria

This new catalogue based on records reported until September 2016 contains 4,450 taxa (4,100 species plus varieties and forms; Dämon and Krisai-Greilhuber, 2017). Species occurrence data compiled in the *Database of Fungi in Austria* was used to estimate parameters essential for conservation status assessment: rarity, habitat specificity, and trends in population size. About 1,300 species (30%) are rare, approximately the same proportion (29%) of species is listed in the categories 0–3: either as vulnerable (VU, 3), endangered (EN, 2), critically endangered (CR, 1), or regionally extinct (RE, 0). Including further 780 (17%) near threatened (NT, 4) species, ca. 2,080 species (46%) are red-listed. Almost 500 species (11%) are known from a single record only. Typical risk factors are eutrophication, habitat destruction and degradation, limited habitat size, and effects of global warming. Many endangered species are bound to endangered habitats. Habitats particularly rich in species of the categories 0–3 are: bogs and similar wetlands (230 species), grasslands and open habitats (200 species), floodplain habitats (180 species), various forest habitats, and alpine habitats.

Documentation of Climate Change Induced Shifts in the Phenology of Macrofungi across Europe

A pan-European mycological meta-database (ClimFun) has been created during the project called ClimFun (Andrew et al., 2017). More than 7 million of fungal species fruit body records from nine countries, including Austria, were assembled into 6 million usable records (taxonomically unclear, doubtful, or double records were omitted) of more than 10,000 species. These fungal data are suitable for addressing macro-ecological questions in order to gain insights into recent climate change effects on fungal phenology and to understand the influence of geographical and climatic variables on fungal fruiting phenology across Europe. In a pending study by Andrew et al. (2017) it could be shown that broad-scale biogeographic patterns in fruiting phenology coincided with seasonal changes in climate and primary production. Across Europe mean fruiting shifted by ca. 25 days, primarily with latitude. Altitude affected fruiting by up to 30 days. Temperature was the strongest driver of autumnal-fruiting ectomycorrhizal and saprotrophic, as well as spring-fruiting saprotrophic groups, while primary production and precipitation were for spring-fruiting ectomycorrhizal fungi. Climate and primary productivity were less predictive of fungal phenology than geography. The network of interrelatedness affecting large-scale fungal phenology patterns could be shown.

Experiences from the Protection of Oak-Dominated Woodlands in Eastern Austria

Between 2010 and 2014, during a program for the protection of near-natural, rare and old growth woodlands, and veteran trees in the easternmost Austrian federal state Burgenland (Waldumweltprogramm Burgenland) co-funded by the EU, 28 natural forest cells could be established with a total area of 336.43 ha (Fiala, 2014). Citizen scientists of the Austrian Mycological Society (ÖMG; Österreichische Mykologische Gesellschaft) assisted voluntarily in providing expertise, mycological data, and locations of candidate sites. Five of the selected forest reserves were proposed by ÖMG because of their rich fungal biodiversity. Furthermore, the reserves Pilgersdorf and Redlschlag share edaphic conditions with a nearby serpentine site investigated and nominated by mycologists (Urban et al., 2008), which could not be included in the final selection. To the best of our knowledge, these were the first protected areas in Austria selected based on fungal biodiversity, a major step forward!

With the beginning of a new EU funding period (2016–2020), renewing of the contracts was necessary. During this process, the forest reserves were re-evaluated. As a result of this revision we were told informally that two of the sites proposed by ÖMG (7Linden and Gornja Loza) are no valuable complementation of the Austrian network of Natural

Forest Reserves and that they will be excluded from the programme. The ÖMG was not involved in the revision process, but expressed its concern and re-informed the administration about the outstanding funga of the contested sites. For instance, Gornja Loza is the habitat of very rare *Russula* species, some of them new for Austria and for science (*R. veternosa, R. nausea,* Pidlich-Aigner, 2009, 2014). Also other very rare macromycetes, incl. *Lanmaoa fragrans* (Figure 1) as well as the yellow-legged bolete (*Neoboletus xanthopus;* Figure 2*;* Urban and Klofac, 2015), newly described in 2015, occur. In the urgent need to prevent forest owners from logging, the two contested areas were adopted by and are currently exclusively funded by members of the mycological society, even though habitat management is not part of the society's usual activities. Currently, a long-term solution for the protection of the two forest reserves is being sought.

In the course of the project, the role of the mycologist involved, mostly citizen scientists, shifted from voluntary data providers to lobbyists out of necessity. We failed to understand why unique fungal hotspots do not qualify as conservation assets and concluded: (1) Fungi do not (yet) belong to the elite club of species to be protected. Despite great efforts no fungal species was included in the European FFH-species programme. (2) Informal counseling and lobbying based on personal networks and voluntary action may partly compensate the lack of specific programs for the protection of fungi and other neglected groups of organisms. (3) However, informal networking and scientific authority are weak forces when it comes to administrative decisions and do not dispense from the need for the explicit inclusion of fungi in biodiversity protection regulations.

An extended version of this section was submitted as stand-alone manuscript to Fungal Conservation, the online-journal of the International Society for Fungal Conservation (http://www.fungal-conservation.org).

ACKNOWLEDGEMENTS

All projects described here would have been impossible without the work of citizen scientists. We wish to thank the Manfred Fiala, Gerhard Koller, Edmund Lentsch, Wolfgang Klofac, Helmut Pidlich-Aigner, Klaus Michalek, and all others who contributed in establishing the first protected areas created for fungal conservation and Gerhard Koller and Wolfgang Klofac for providing photographies.

FIGURE 1: *Lanmaoa fragrans,* Gefährdeter Pilz des Jahres 2014 (http://www.univie.ac.at/oemykges/wp-content/uploads/2016/11/Pilz_des_Jahres_2014.pdf). ©Gerhard Koller.

FIGURE 2: *Neoboletus xanthopus,* type collection. ©Wolfgang Klofac.

Keywords: macromycetes, fungal biodiversity, fungal conservation, fungal ecology, species distribution

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Simplified Butterfly Observation: Development and Evaluation of an Assessment Scheme Suitable for Young Students

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INTRODUCTION

Although the ongoing global biodiversity crisis is generally recognised as a major threat to human welfare (Rockstrom et al., 2009), it is continuously unchecked. Biodiversity monitoring programs are a possibility to investigate and illustrate the effects societal actions have on nature (Rüdisser, 2015). Biodiversity monitoring depends on regular and lasting data assessment over large areas. Meanwhile, many international citizen science projects have shown that involving adults and often experienced volunteers can substantially contribute to the implementation of such monitoring tasks (Amano et al., 2016), few studies have focused on juvenile or non-experienced volunteers. The Sparkling Science (www.sparklingscience.at/en) project Viel-Falter (www.viel-falter.at) was designed to examine whether and how trained and supervised pupils, aged 6–19 years, together with their teachers are able to systematically collect data on the occurrence of butterflies. If the achieved data quality is sufficient, regular butterfly observation conducted by schools could contribute to a financially feasible butterfly-monitoring scheme and, at the same time, promote authentic opportunities for environmental education.

METHODS

We developed and applied a simplified assessment scheme for butterflies suitable for young students or any other layperson. From 2013 to 2015, 548 pupils aged 6–19 years and from 14 schools collected data at 35 different sampling sites in Tyrol, Austria. These pupils conducted 2,616 individual butterfly assessments during 159 field trips. To evaluate data quality and its predictive power for butterfly habitat quality, the butterfly fauna at all 35 sites was independently assessed by professional butterfly experts. Experts performed four comprehensive butterfly assessments on species level. Besides a detailed evaluation of the factors influencing data quality, we also investigated how pupils' motivation to engage in butterfly monitoring developed during the project and which project factors support continuous collaboration. For this, all pupils engaged in the project were asked to fill an anonymous online questionnaire at the beginning and at the end of the project.

RESULTS AND DISCUSSION

Although the comparison of the data collected by pupils with the expert assessments revealed varying and substantial identification uncertainties for different species or species groups, they were successfully used to predict the general habitat quality for butterflies (Rüdisser et al., 2017). These results indicate that the data collected with the simplified assessment scheme can provide valuable information to spatially comprehensive monitoring of butterfly habitats, and hence complement professional data collection. However, 3 years of field campaigns revealed remarkable variation in the engagement and organisational flexibility among the participating schools. Furthermore, participating pupils and their teachers require a high level of support and supervision to ensure a reasonable data quality. Involving schools in butterfly observation promotes authentic opportunities for environmental education and has very positive multiplier effects. Introductory workshops conducted with all involved school classes at the beginning of their project participation proved to be very important tools: not only support the environmental education objectives, but also improve the assessment quality. The online survey among the participating pupils showed that they participated with a very high degree of interest and enjoyment and that they perceived themselves as competent (Rafolt, 2015). While at the beginning of the project already 85% of the pupils agreed that the work in the project is interesting, this level even increased to 88% after the first project year. Various participating schools enhanced the project by organising additional peer-teaching or environmental protective activities. Some pupils opted to voluntarily contribute by providing further observations conducted by them individually in the school holidays. Data quality generally improved with an increasing freedom of choice regarding their individual participation and involvement in the project.

While the methodology and the observation framework developed in Viel-Falter already showed its potential to contribute to a biodiversity monitoring, measures to improve and guarantee data quality should be further investigated and applied. Such measures include: (a) involving trained volunteers to complement butterfly assessments conducted by school classes, (b) guaranteeing a minimum level of knowledge through participant training and introductory courses, (c) applying a data review system using a combination of online application and personal communication, (d) using rule based systems utilising information about the experience of participants or other metadata to filter data for analysis (Dickinson et al., 2010; Roy et al., 2012), (e) newly developed measures based on participant feedback and experiences gained during the project, and (f) considering issues of data error and bias during analysis using suitable statistical tools (Bird et al., 2014). For this, the methodology and the observation framework including the web platform will be extended and adapted for broad public participation.

ACKNOWLEDGEMENTS

Our special thanks go to 24 teachers and 548 pupils of the participating schools (BRG in der Au, HLW Kufstein, NMS Fließ, NMS Längenfeld, NMS Umhausen, NMS Weer, PHT/PMS der Pädagogischen Hochschule Tirol, Reithmanngymnasium, VS Brandberg, VS Innervillgraten, VS Obsteig, VS Schwendt, VS Steinach, and VS Tux). The project Viel-Falter was financially supported by the Federal Ministry of Science, Research, and Economy (Sparkling Science Project Viel-Falter, SPA 04/018 and Top Citizen Science Initiative; TCS 12 Viel-Falter TCS).

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Project StadtWildTiere: Benefits and Constraints in the Involvement of Citizen Scientists

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INTRODUCTION

With increasing urban areas worldwide and the human population living within them (United Nations Department of Economic and Social Affairs Population Division, 2015), those areas and habitats are becoming more and more interesting for scientists researching wildlife living in cities (Baker and Harris, 2007; Bateman and Fleming, 2012). The citizen science project StadtWildTiere was established in Vienna, Austria in May 2015. A focus of the project is to find out more about the occurrence and distribution of mammals in the capital city of Austria, as well as in-depth research in the area of urban wildlife ecology in consideration of relevant stakeholders and an increase in professionalism of bilateral knowledge transfer between society and research. Here, we present our experiences on benefits and constraints in the involvement of citizen scientists after 20 months of project duration.

MATERIALS AND METHODS

The study area is Vienna, the capital city of Austria (48° 12' 30" N, 16° 22' 21" E) with a total area of 414.87km^2 and about 1.84 million inhabitants in 2015. Green areas like parks and gardens make up 45.1% of the city area, 35.8% are building areas, 14.4% are traffic areas, and 4.7% are of waterbodies (MA 23 - Wirtschaft, Arbeit und Statistik, 2016).

Exactly 5319 sightings were gathered through the internet platform of the project www.stadtwildtiere.at over a period of 20 months (May 27th 2015 to January 25th 2017). Citizen scientists entering data are required to enter a place via a google map, species observed as well as time and date when the animal was seen. Registration is not mandatory. When registering, citizen scientists can upload photos of their sightings and benefit from additional features. Data is evaluated and then ranked according to liability of sightings. All analyses were done using statistical software R 3.2.1 (R Core Team, 2014).

RESULTS AND DISCUSSION

Of the reported sightings, 68% were encounters with mammals, whereas 26.2% sightings reported birds, amphibians, and reptiles (2.9%) or other animals (2.9%). Foxes (*Vulpes vulpes*) were the most frequently reported species (n=935). We experienced some constraints in working with citizen scientists when considering the different species that are reported. In our experience, the way people feel about different animal species can have an influence on the reporting of those. While rats (*Rattus norvegicus*) are common animals in urban areas and can frequently be observed in Vienna (A. Desvars-Larrive, personal communication), they are hardly reported (n=30) within our project. This is most likely due to being regarded as pest species rather than as wildlife. The same might be applicable to moles (*Talpa europaea*; n=5), edible dormouse (*Glis glis*; n=4), and different vole species (*Arvicolinae* sp. n=17). People rather tend to report animals, which they does not expect to see within the city (for example red foxes) or animals which cause conflicts, e.g., badgers (*Meles meles)* digging burrows underneath garden sheds or terraces. This has to be taken into account, when conclusions on distribution of animals are drawn from citizen science data.

However, the benefit of including citizen scientists in urban mammal research is not only the number of sightings many people can gather together, but also that it enables scientists to collect many of observations from hardly accessible land use classes (Lepczyk et al., 2004; Dickinson et al., 2010; Weckel et al., 2010), as also the example of our red fox data shows: 35% of these observations were made in private gardens or in residential areas.

497 citizen scientists registered for data entry. On average, they reported 8.73 sightings (σ=80.34). Nonetheless, there are single observers that report many more sightings than the average and can therefore influence the data base. This can be another constraint when working with citizen scientists. We recommend not only to check how many reports are made by single observers, but also if spatial distribution or distribution of reported animal species will have an impact on the results of planned analyses.

Constraints can also be time. In the project StadtWildTiere communication with citizens happens on a regular basis, as every sighting reported is checked for plausibility and correctness. Thus, if the time or place of a reported sighting is not entirely plausible or if different information on the place of sighting is reported on the map and in the comments, citizen scientists are contacted by scientists in order to clarify sighted species, place or time. The numbers of hours going into communication should not be underestimated, as also information about animals living in the city and about conflict management are given per email and phone on a regular basis. However, the contact with citizens is important to keep data quality as high as possible, and also to motivate them.

Within the project StadtWildTiere, we benefit from the photos our citizen scientists submit to the project. We could develop public relations material like folders, roll-ups, and newsletters with the high quality photographs the citizen scientists offered us to use and are proud that we could realize the development of such material together.

For the future, we want to further enlarge the group of interested citizen scientists. We are thinking of assigning certain areas of the city to people, who are willing not only to report sightings from this region, but also to get further involved via other monitoring methods such as camera traps or track tunnels for small mammals. We believe that using citizen science is a suitable method to investigate occurrence and distribution of urban mammals. In our opinion the benefits balance the constraints one will encounter and mitigation of constraints is possible in different ways.

ACKNOWLEDGEMENTS

We are grateful to all citizen scientists who invest their time and submit their sightings to our platform.

Keywords: citizen science, urban wildlife, human–wildlife interactions, urban ecology

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