

Exploring citizen science in post-socialist space: Uncovering its hidden character in the Czech Republic

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Abstract

Citizen science is a relatively new phenomenon in the Czech Republic and currently a general overview of existing citizen science projects is not available. This presents the challenge to uncover the ‘hidden’ citizen science landscapes. The main objective of this paper is to explore the (public) representation of citizen science (CS) projects and to describe their heterogeneity. The study aims to answer the question of what type of projects in the Czech Republic meet the definition of citizen science. Based on a specific methodological data-base search approach, we compiled a set of CS projects (N = 73). During the classification process, two general citizen science categories were identified. The first group (N = 46) consists of “pure” CS projects with a prevalence towards the natural sciences, principally ornithology, and thus corresponding to general European trends. Citizens usually participate in such research in the form of data collection and basic interpretation, and a high level of cooperation between academia and NGOs was detected. The second group of “potential” CS projects (N = 27) entails various forms of public participation in general, frequently coordinated by NGOs. Based on these results, we discuss the position of citizen science in the Czech Republic, including socially-oriented citizen science. Further research is strongly encouraged to achieve a more in-depth insight into this social phenomenon.

Keywords: citizen science, participation science, nongovernmental organisations, academia, public engagement, natural sciences, social sciences, Czech Republic

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1. Introduction

Citizen science is usually explained by various authors as an engagement of citizens, enthusiastic amateurs or non-scientists, in scientific research through various forms and levels of participation and during various stages of the research work (e.g. Bonney et al., 2009; Silvertown, 2009; Dickinson et al., 2012; Shirk et al., 2012; Haklay, 2013). Traditionally, the domain of citizen science lies in natural and environmental sciences, where collecting a vast amount of data by volunteers is welcome, effective and facilitative (e.g. Cohn, 2008; Cooper et al., 2007; Miller-Rushing, Primack and Bonney, 2012). Social sciences and humanities research projects have recently come to the fore, calling for better cooperation with citizen science, stressing the potential of the democratisation of scientific knowledge (Wannemacher et al., 2018), and promoting political decision-making processes involving the environment and health (Kullenberg and Kasperowski, 2016), and the empowerment of grass-roots initiatives to conduct research (Mahr et al., 2018).

As in other post-socialist Central and Eastern European (CEE) countries, the Czech Republic has experienced different temporalities in the conceptualisation and societal acceptance of citizen science. The primarily exploratory character of our study shows that the proper term “citizen science” or “participatory science” (in the Czech language often translated as “občanská věda”) is not frequently used in the country, despite evidence of citizen science-related practices taking place. This difference is often seen as an “allochronic delay” (Bevernage, 2016) beyond “normal” developments in Western countries. Instead of this geopolitically uneven interpretation, we prefer one based on the different meanings of citizen science in post-socialist space. Citizen science in post-socialist countries appears to be veiled by a certain “invisibility”, further specified by the Hungarian researcher Bálint Balázs (2019) as “...invisibility of citizen science practices in the non-Western countries. In many central European countries, even the term is not recognised. This apparent division in the performance of

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citizen science between Eastern and Western countries reflects an unequal knowledge production.” In contrast to Western countries, social sciences in the former socialist Czechoslovakia suffered from a dominance of the positivist approach and a negligible application of qualitative methods, particularly with respect to participatory research (Konopásek, 1999). Even 30 years later, participatory research or citizen science in the fields of human geography and environmental studies remains a largely marginal methodological approach.

Various scientific papers dealing with citizen science have recently been published (mostly in Czech) in the Czech Republic: a study researching dragonflies used a citizen science approach (Ožana et al., 2019); similarly, a text on ornithological research (Diblíková et al., 2019); and several papers exploring the concept of GeoParticipation, which is (in some respects) closely connected to citizen science (e. g. Pánek et al., 2017). Most other contributions fall within the sphere of grey and/or popular literature. A growing number of articles popularising Czech citizen science have recently appeared in social media, popular journals, and the daily press (e. g. Vesmír, Botanika, Idnes). Paradoxically, one of the best reviews of citizen science in the Czech Republic to date is a Bachelor’s thesis by a library and information science student (Kalmárová, 2015). In general, librarians and information scientists are among the most active supporters of citizen science, and strongly encourage the role of public libraries as vital public institutions supporting education, research and information exchange (Černý, 2016).

In the field of geographical research, but also in urban planning and regional development, some prospects for future research can be seen in the various forms of participation in geographical research (GeoParticipation), especially in using research techniques of emotional mapping, which has been recently developed and applied in several towns in the Czech Republic (Pánek and Pászto, 2016; Pánek, 2017). The debates about citizen science and its role in social and geographical research can enrich discussions about sustainable spatial development in post-socialist space, especially in the sense of introducing non-hierarchical relations between researchers and for those who participate in research and are striving for change [i.e. the Critical Geography imperative] (Osman, 2013).

Based on this introduction, we can summarise that citizen science is a relatively new phenomenon in the Czech Republic, one which is not integrated into existing institutional structures and hence results in uncoordinated management, with no overviews of existing citizen science projects. The authors of this paper have endeavoured to uncover or reveal the hidden citizen science landscapes in the Czech Republic with their two primary research objectives: (i) to “Describe the heterogeneity of CS projects in the Czech Republic”; and (ii) to answer the general question: “What types of projects meet the definition of citizen science in the Czech Republic?”

2. Conceptualisations and definitions of citizen science

2.1 Principal definitions of citizen science

As previously stated, the engagement of the public in the research process is a key aspect and at the same time a condition of what is usually regarded as citizen science.

Various typologies and scales of citizen science have been formulated according to the level of public engagement (e. g. Haklay, 2013; Shirk et al., 2012).

For the purposes of this study, we utilised the classification of public engagement proposed by Haklay (2013), which is closely related to geographical research, especially in the field of GeoParticipation or Volunteered Geographical Information (see, e.g. Goodchild, 2007). Haklay (2013) identifies four basic levels of citizen science from low-level participation to high-level participation, usually designated graphically in the form of a “ladder”. On the bottom level is crowdsourcing, as basic data collection mostly through desk-top analysis or by simple field methods, followed by distributed intelligence as more intensive participation of the public in the first stages of the research process, which usually requires additional work and basic interpretation of the collected data. The third level, called participatory science, is perceived rather as a partnership: more in-depth cooperation between scientists and the public in selected stages of the research process, which starts with the elaboration of research questions and ends with data analysis. Extreme citizen science almost dismisses the science/citizen divisions and encompasses an entire range of mostly bottom-up research, which responds to community needs and is aimed at improvement or even societal change. In later studies, Haklay (2018) has enlarged his focus on participation with other dimensions, reflecting the development of a knowledge society, creating a combination matrix of four blocks (ranging from a [low level of knowledge/low engagement] to a [high level of knowledge/high engagement]).

Traditionally, the thematic classification of CS projects goes hand-in-hand with scientific classification, based primarily on a natural/social science divide. Besides the level of participation, the proportion of projects between natural and social sciences in this field can be evaluated. Some interesting findings concerning the conceptualisation and varying position of citizen science in different scientific disciplines have been indicated by Kullenberg and Kasperowski (2016). In the largest group, which is mainly composed of the natural sciences, citizen science serves mostly as a methodology for data collection and processing, which corresponds to other similar studies, such as Bhattacharjee (2005), Anderson (2013), Gosling et al. (2016), and Silvertown (2009). A second group, according to Kullenberg and Kasperowski (2016), consists of geographic information research, and citizens are perceived as participants in research, collecting geographic data. Contrary to this conceptualisation, Parrish et al. (2019) stress that involving citizens in CS projects can go beyond collecting and analysing scientific data.

Even if citizen science does not represent a typical approach in the social sciences, according to Ryan et al. (2018) there are some specific participatory approaches such as community-based participatory research (CBPR) and participatory action research (PAR), which generally correspond with social science research. Social scientists understand citizen science differently from natural scientists through a lens of the democratisation of scientific knowledge production, as stressed by Mahr et al. (2018). Kimura and Kinchi (2016) perceive social citizen science as a process in the democratisation of society, and see the potential to open up science institutions, policymakers, and other stakeholders to more democratic public participation.

The principal idea of both the social sciences and the humanities in relation to the citizen science concept, is the empowerment of relationships between science and society and in filling the gap between local communities and other stakeholders in the face of environmental or social challenges (Mahr et al., 2018; Ryan et al., 2018; Wannemacher et al., 2018; Joy et al., 2011).

Ethical aspects connected with social science research are raised and discussed by Purdam (2014), who uses the term “social citizen science” and renews the idea of “emancipatory social science”. Using the example of a research study mapping begging, she points out that observations of humans, together with data collection, implies serious questions of research ethics and opens up sensitive issues, such as privacy, embarrassment and intimacy.

To summarise, public (citizen) participation in general – the involvement of the public in decision-making and planning processes, as well as community development – is a key principle of modern democracy and constitutes great potential for further utilisation in citizen science. Based on the preceding discussion, there appears to be a slightly different meaning of citizen science in the natural and social sciences. In the natural sciences, citizens usually help scientists to conduct research and serve more or less as adjuncts or field assistants, whereas social scientists provide a different view of public participation. First, social scientists have already identified numerous approaches encompassing public participation, such as community-based research and participatory action research (utilised in geography as GeoParticipation or Volunteered Geographical Information), so renaming this successfully established terminology as citizen science could be misleading. Second, the participation of citizens in social science research is more “radical”: it contributes to societal changes and the reframing of society, and citizens tend to be viewed as reflexive partners. Finally, a rather mechanical application of citizen science methods in the social sciences could generate serious ethical questions concerning privacy and other sensitive issues.

2.2 Geographical context of the study:

The hidden landscapes of Czech citizen science

To map the Czech citizen science landscape, we identified and investigated three potential sources of recruitment for citizen science in the Czech Republic. The first is from traditional hobby and amateur organisations, the second from social movements and bottom-up initiatives, while the last one consists of the application of participatory methods in social research.

2.2.1 *Traditional engagements of amateurs in society and science*

There is a long tradition (in many countries, as well as in the Czech Republic) of various amateur civic associations, evolving from the late 19th century, in the fields of nature protection, beekeeping, entomology, ornithology, librarianship, hunting and gardening, etc. (e. g. Tóth et al., 2018). Based on principles of voluntary engagement and self-organisation, enthusiasm and interest in a particular topic, these associations provide a fertile base for cooperation with scientists (some scientists may also be their members), especially due to strong organisation and more or less massive membership (ranging from thousands to hundreds of thousands of members). Members also actively exchange information and periodically publish their own professional journals (e.g. ornithologists, hunters, conservationists, beekeepers, etc.).

According to Diblíková et al. (2013, 2019), scientists usually regard the role of these amateurs as highly beneficial for the collection of geographically-scattered data about selected species (plants, animals, birds, insects, etc.). Others appreciate the possibility of longer-term research, replacing their own lack of research capacities, for example, in water quality monitoring (Fabšičová, Fránková and Šumberová, 2017) or in the observation of phenological changes in nature during and after the vegetation season (Dušková, 2019). Thus, ornithologists help to monitor and protect birds (Diblíková et al., 2019), hunters observe field birds and forest animals, conservationists count endangered species and old varieties of fruit trees, amateur meteorologists track weather, etc. Moreover, they can propose their own research problems and work on many projects. Most importantly, in the event of a crisis, they are able to act to protect their rights or the perceived rights of the subjects of their interests. In general, their work is supported and promoted (for example, through financial donations) by the public (Krajhanzl et al., 2015; Krajhanzl, Chabada and Svobodová, 2018; Tóth et al., 2018).

2.2.2 *The rise of social and environmental movements*

Unlike these traditional hobby and amateur organisations, activities of a more confrontational nature (especially in the field of social and environmental justice) were suppressed during the socialist era (Vaněk, 1996). Since the 1980s and 1990s, social and environmental movements have begun to partake in and reshape Czech society, exhibiting collaborative as well as confrontational attitudes towards the establishment (Fagin, 2000; Vaněk, 1996; Císař, 2008). Undoubtedly, all these societal trends have also influenced science, both natural and social, and contributed to challenging their functions in a changing world.

Among the most successful environmental organisations are Hnutí DUHA [Friends of the Earth Czech Republic] (environmental issues and small-scale farming), Arnika and Děti Země [Children of the Earth] (environmental pollution and transport), and Frank Bold (law and environmental counselling). Several foundations (Partnerství [Czech Environmental Partnership Foundation], and Veronica) support civic society and sustainable development projects, frequently based on participatory principles.

Finally, there is a strong stream of environmental education adhering to the principles of education for sustainable development and inquiry-based education. This includes numerous active organisations and educational centres. Most of these are scattered across the regions, and at the state level are connected through the Pavučina [Network of Environmental Education Centres in the Czech Republic].

The potential for mutual scientific cooperation with actively engaged citizens, whether as individuals or united in various civic associations, is perceived as one of the pillars of civil society, as stressed in the publication: “Science and nongovernmental organisations: experiences, possibilities, inspiration” (Čada, Ptáčková and Stöckelová, 2009). In this book, Zelený kruh [Green Circle], as a coalition of Czech non-governmental environmental organisations, explores potential ways of science – NGO collaboration, mentioning many foreign examples, such as community-based research, science coffees, etc. Various forms of public participation and engagement have been continually developed and applied in the processes of community development, participatory urban planning, nature protection, and solving various social and environmental issues, partly based on productive

citizen – NGO – science cooperation or in active civic life (Kroupa and Mansfeldová, 2006; Krajhanzl et al., 2015; Krajhanzl, Chabada and Svobodová, 2018).

2.2.3 Application of participation methods in social and, specifically, geographical research

Geoparticipation, also referred as participatory GIS and public participation GIS (abbreviated as PGIS), emphasises the connection between citizens, spatial science, (new) technologies and public engagement (see e.g. Thompson, 2016). Spatial planning using advanced GIS technologies could greatly benefit from public engagement. Tools for incorporating laypersons into public agendas vary from basic forms of collecting data (such as crowdsourcing), through “fix-my-street” applications (such as Járókelő: see Marietta, 2016) to designing urban space and facilities (Pánek et al., 2014, 2017). Most of the geoparticipatory approaches (there is also a decision support tool for selecting the optimal participatory mapping method – see Pánek, 2015) involve the basic principles of citizen science. The scale of usability covers all forms of research areas/ fields that could be widely used (from the geographical point of view).

Most of the cases classified as “geoparticipation” use GIS technologies. A good example is the OpenStreetMap (OSM) project, in which people edit a freely available map to obtain the most detailed and accurate map in the world. In some cases, OSM could serve for purely humanitarian purposes (Trojan, 2015) where participation is the main role. OSM has become one of the most used cartographic backgrounds in other geoparticipatory projects. Czech involvement in geoparticipation is quite high (compared to the situation worldwide). Geoparticipation has been used in many projects and often combined with mental mapping (Pánek, 2016). All of these volunteer activities covered by geoparticipation create a lot of useful data for further research and contribute to increasing information and knowledge in the field (Sui, Elwood and Goodchild, 2013).

2.3 Existing attempts to map or analyse the landscapes of CS projects

Despite the continuing increase in citizen science theory and practice, associated with the growing citizen science literature, overviews and analyses of existing CS projects with a specific geographical focus are quite rare. There are various reviews of the literature in citizen science, such as that by Follett and Strezov (2015), but one of the most comprehensive works is the meta-analysis by Kullenberg and Kasperowski (2016). In addition to a common finding of the growing number of studies related to citizen science, they analysed the distribution of work by scientific disciplines. The highest number of articles was found in biology and conservation research (specifically, the Web of Science shows the highest occurrence of terms such as ecology, environmental studies, geography, environmental science, and biodiversity conservation with respect to citizen science).

Another content analysis of CS projects was conducted by Ferran-Ferrer (2015), again with respect to the distribution of academic disciplines: this author similarly revealed that the arts, humanities and social science disciplines were almost non-existent. Interestingly, this contribution also points out that projects in the field of natural and physical sciences are fostered by a top-down approach and receive more financing from EU funds.

Some reviews do focus on collecting and analysing existing literature sources in a specific area, however, and describe, for example, volunteer environmental monitoring and how it influenced the participants who took part in the research (Stepenuck and Green, 2015). These authors found that the participants mainly expressed positive effects, such as increased personal knowledge and community awareness, changing attitudes and behaviours, the building of social capital and even beliefs in influencing change in natural resource management and policy. Although similar studies serve as useful insights into citizen science, they do not provide a satisfactory geographical picture of citizen science projects.

To assist in mapping the landscape of CS projects covering a given geographical area, many national and international collections or inventories of CS projects have been compiled in order to raise public awareness of projects and to popularise the phenomenon, or to advertise the possibility of participation. Just a few of most popular are SciStarter, CitSci, Ala Bio Collect (Atlas of Living Australia). A thematic mapping of projects dealing with citizen science and smart cities in Europe was carried out by Craglia and Granell (2014), although their study only enumerates and describes selected projects, without any further analysis.

A highly relevant source and inspiration for this study is an example of a citizen science investigation carried out on European-level on-line research conducted in 2016 by Hecker, Garbe and Bonn (2018). These authors conducted the first large-scale exploratory survey among CS project coordinators (N = 174), studying various aspects of the citizen science landscapes of Europe. They received the highest number of responses from Germany (34), followed by the UK (33) and Austria (25). Only three responses came from the Czech Republic and one from Slovakia, while other CEE countries showed similar numbers: Slovenia (1), Poland (3), Lithuania (1) and Estonia (3).

In terms of general research areas, Hecker, Garbe and Bonn detected the prevalence of the life sciences (75.7%), with the second-highest frequency among the humanities and social sciences (11%), followed by natural science (7.5%) and engineering (5.8%). The distribution of scientific disciplines was as follows: ecology (27.2%); environmental sciences (22.5%); biology (15.6%); and zoology (15.6%). More socially-oriented disciplines, such as sociology (4%), transport (2.9%) and geography (2.9%), occupied 5–7th positions. Some interesting findings are related to the coordination of CS projects, which show the dominance of academia in leadership: almost one half of the surveyed projects were coordinated by a scientific organisation (45%), followed by educational organisations (14%) and NGOs (11%).

Another research initiative, even though primarily focused on environmental policy, is the report for the European Commission (Bio Innovation Service, 2018). More than 500 European CS projects were collected and analysed according to their contribution to Sustainable Development Goals (SDGs) and in relation to environmental policy (United Nations, 2019). The geographical distribution of CS projects was of interest: highest in the UK, France and Spain, but quite low in CEE countries. The findings show the dominance of NGOs' leadership (41%), followed by academia (29%), government (12%), mixed consortiums (11%) and private companies (3%).

The main environmental domains of CS projects in this report focused on nature and biodiversity (69%), mostly through monitoring or the occasional reporting of species occurrences, while other natural resources (air, water, land) were only represented at 3% to 7%. Environmental risks and health contributed only 1% each. In the case of the SDGs, the highest contribution was to nature conservation (water and terrestrial) in contrast to those SDGs focusing on socio-economic and community aspects (poverty, gender, food, water, sustainable energy, sustainable cities, etc.).

These studies present at least two analytically interesting findings. First, there is a clear over-representation of research from Western countries while, on the other hand, a significant under-representation of research from post-socialist countries. Second, all the research findings confirm the strong dominance of the use of citizen science in natural science disciplines over its use in social science disciplines.

3. Methodological approach

3.1 Step-by-step search for CS projects

Citizen science is a relatively new phenomenon in the Czech Republic, and it has not been integrated into existing institutional structures, so that there is no coordinating management or overview of current citizen science projects. In order to address our research goals, it was necessary to create our own database of CS projects. Since no such database has existed until now, a purely inductive method was adopted.

The search for CS projects in the Czech Republic took place from August 2018 to February 2019 and consisted of several steps. Firstly, we searched for projects within the scientific literature. The terms Citizen Science, Participatory Science, Participatory Mapping, Participation, GeoParticipation in combination with the Czech Republic, Czechia, Bohemia, Moravia and Silesia in English and Czech languages, were subject to search. The next step was a similar search for information on public web-sites through the Google and Google Scholar full-text search engine, in general, complemented by several secondary information sources, such as the Národní úložiště šedé literatury [National Repository of Grey Literature], the Souborný katalog Národní knihovny [Union Catalogue of the Czech Republic] (CASLIN), and Centrální evidence projektů [Central Evidence of Scientific Projects]. Web pages of the Czech Academy of Sciences were also explored, such as all universities and the research institutions of the Czech Academy of Sciences, and especially those universities with a geographical orientation. Third, the web pages of selected non-governmental organisations enabled us to obtain a preliminary insight into the issue. Finally, the personal knowledge and contacts of all members of the authors' team were used. All six co-authors turned to partners in their social networks and specialist scientific communities, NGOs, public institutions and supporters of citizen science, asking whether they knew of a project with a scientific focus that involved the general public. The data obtained from these three levels of inductive search became the bases for a database of participatory-based projects, which included 82 unique cases.

3.2 Database creation and its limitations

The database created in this way, however, has a number of limitations that need to be highlighted before proceeding with further analysis.

3.2.1 Limitation 1: The scope of the search was affected by subjectivity

The origin of the database was heavily influenced by the subjectivity of the authors' collective associations, especially their affiliation to certain scientific communities and the extent of their social networks. From the point of view of specialisation, the database is influenced by the easier search of citizen science projects in the fields of the authors' collective. These include social geography, physical geography, natural and environmental studies, cartography and geoinformatics. A lower representation of projects outside the scope of the authors' team cannot, therefore, signify only the absence of projects in these disciplines but rather point to the specificity of the creation of this database.

3.2.2 Limitation 2: Social networks of the authors' team

The authors are well aware that their social networks cover universities, research institutions, educational institutions, specialist scientific communities and non-profit organisations. To a much lesser extent, they cover the private sector, self-government and state administration. The integration of participatory methods in the decision-making processes of Czech municipalities (participatory budgets, participatory planning, participatory mapping) has been increasing in recent years, which in some cases can be used creatively to generate new scientific knowledge. We are aware of these developments, but they are not primarily designed as citizen science, and so they were not included in this database. The effect of this limitation is thus seen in the fact that the citizen science projects in this database are more strongly connected to research and educational organisations than to other organisations.

3.2.3 Limitation 3: Projects using participatory principles do not directly imply citizen science

Thirdly, the database is limited by the fact that it includes projects that met some aspects of public participation in general, but it does not necessarily cover the entire definition of citizen science projects. In other words, the 82 projects included in the original database are not directly citizen science projects, but rather projects using (geo)participatory principles. This may cause difficulties in interpretation because it is not possible to generalise findings or conclusions to the overall situation of citizen science in the Czech Republic. The compiled database is the first in the Czech Republic, it is incomplete and, therefore, necessarily includes selected citizen science projects. For this reason, the goal of this article was formulated in such a manner that it does not aspire to describe the complete set of citizen science projects in the Czech Republic, but rather to describe the heterogeneity of CS projects in the Czech Republic or to better capture the variety of forms in which citizen science has manifested itself in this specific post-socialist context.

3.3 The classification and analysis process of CS projects

The database was analysed in several successive steps. Firstly, we excluded projects that did not meet even the most broadly-conceived definitions of citizen science, as discussed above, or were not primarily linked to the territory of the Czech Republic. Thus, global projects such as Wikipedia and OpenStreetMap, or projects from Slovakia, which were partially implemented in the Czech Republic, were removed. In total, nine projects were excluded at this stage; hence, only 73 unique projects entered into the next phase

of the analysis. These procedures were driven by the need to cope with the relatively large heterogeneity of citizen science definitions. The whole database was split into two parts: the first part – socially-oriented projects complying with a relatively strict definition of citizen science; and the second part, using a more open definition. The first part of the database – “pure” citizen science – was defined according to Haklay (2013) and contained 46 unique projects; the second part – “potential” citizen science – was classified more generally and contained 27 unique projects (see Fig. 1). In the final stage of the analysis, both parts were analysed separately.

For both groups, we applied a general classification schema and described all CS projects using these categories: title, general description, aim of the project, main coordinator, stakeholder(s), the geographical scope of the project, contact information and start year of the project (if detected). In the thematic classification of the projects, however, we used a diverse approach for each group.

The first part of the database was further analysed according to Haklay’s (2013, 2018) levels of participation, and was classified into the following categories of citizen science: crowdsourcing; distributed knowledge; participatory; and extreme. The thematic scope of pure CS projects was classified according to a comprehensive international classification recommended by OECD (OECD, 2015). We mainly utilised the first two levels of classification, which we slightly simplified and adjusted for the purpose of our database. The primary level of classification is based on six primary research areas. The secondary level identifies 42 potential specific research fields within the disciplines. The third level serves as complementary and includes 44 variations of pre-selected detailed research topics to obtain a comprehensive picture of CS projects.

The second part of the database serves primarily to describe the potential for citizen science ($N = 27$), which can be identified in a number of projects, but which is not yet fully developed into citizen science. For classification purposes, we used somewhat simplified themes at two levels. The first level included six primary research areas, the same as for the first group. The second level used simplified themes such as the environment, librarianship, public space, gardening, transport, safety, waste, animal

protection, food, fix my street and historical heritage. Both parts, however, do meet the stated goals and respond to the research question: “What type of projects meet the definition of citizen science in the Czech Republic?”.

4. Results

4.1 Geographical distribution of pure CS projects

The spatial distribution of CS projects in the Czech Republic, according to the address of the main project coordinators, is presented in Figure 2. The highest number of projects is closely related to larger towns such as Prague and Brno, where universities, public and academic institutions are located. In one case with more principal coordinators, the partnership was again between Brno and Prague. Quite interestingly, local projects are usually operated by local (or smaller) universities, particularly in case of Volunteered Geographic Information.

Another level of cartographic representation addresses the territorial scope of the project. Most of the defined projects covered the whole of the Czech Republic, while several projects had a limited local scope due to the specificity of their research. For example, earthquake monitoring is bound to Western Bohemia due to the prevalence of this natural phenomenon in that part of the country (with several insignificant exceptions elsewhere). On the other hand, only a few projects were oriented to a wider scope and collected data from Europe or all around the world. All of these latter projects were located either in or close to Prague.

4.2 Scientific classification of pure CS projects

Based on our database of 46 citizen science projects, we detected the following distribution, represented in Figure 3. A clear majority of projects represented natural sciences (80%) as the primary research area, followed by the social sciences (9%) and agriculture (4%). The other three research areas (engineering, medicine, and humanities) are each represented by one case only.

These results, which show the predominance of natural and life sciences, correspond strongly with similar research on CS projects, such as Hecker, Garbe, and Bonn (2018), or the literature review by Kullenberg and Kasperowski (2016).

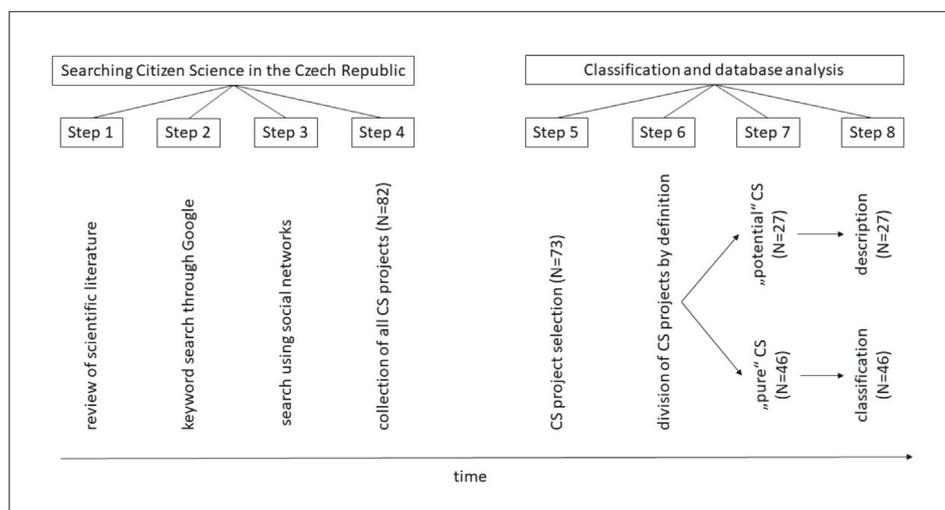


Fig. 1: Phases of investigation, classification and database analysis process.

Source: authors' elaboration

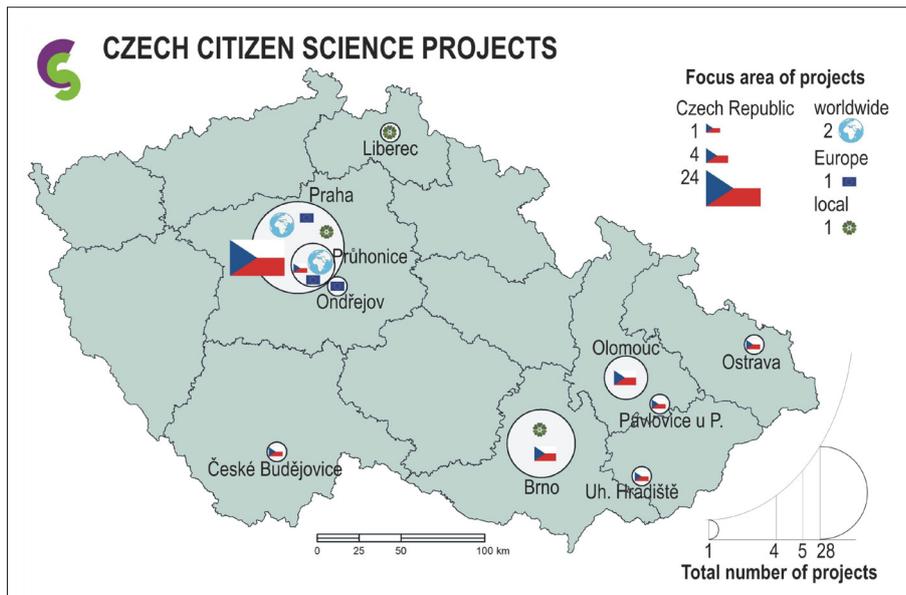


Fig. 2: Spatial distribution of pure CS projects
Source: authors' research

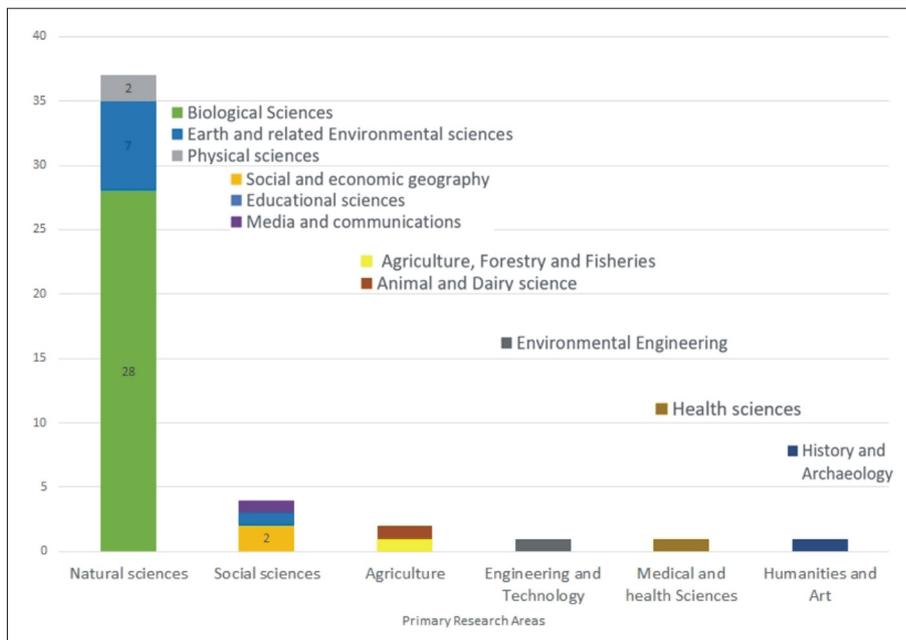


Fig. 3: Distribution of research areas (column descriptors) and research fields (legend) of citizen science projects in the Czech Republic. Source: authors' research

The second level classification revealed a more detailed distribution of research disciplines. Again, the highest prevalence is in biological sciences (28 cases), followed by earth and environmental sciences (7). No other research discipline was represented by more than two cases.

An even more detailed breakdown of research topics clearly shows the dominance of the biological sciences. We counted ornithology in 16 cases, followed by zoology (4), biology and conservation (3), education (3), hydrology (3), meteorology (3), urban studies (2), entomology (2) and botany (2). Other research topics are each represented by one case only.

4.3 Coordination and cooperation in pure CS projects

As for the coordination and supervision (both self and mutually coordinated) of citizen science activities, academia

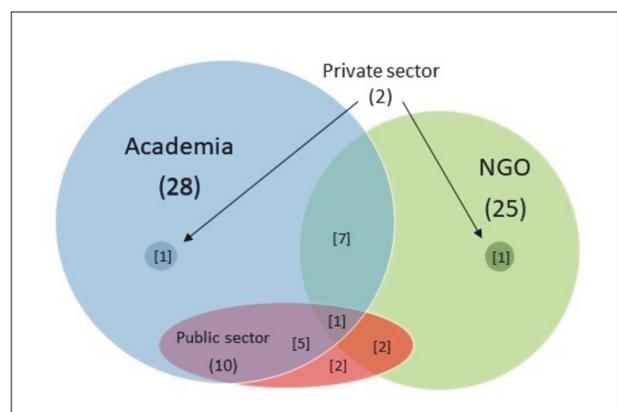


Fig. 4: Coordination of CS projects in the Czech Republic
Source: authors' research

(28) and NGOs (25) are responsible for most of the projects. The public sector (10) and, in particular, the private sector (2) play a lesser role in Czech CS projects.

The relationships presented in Figure 4 show the self-coordinated and mutually-coordinated citizen science initiatives in the Czech Republic, according to the type of stakeholder. The numbers in round brackets represent the total amount of initiatives per stakeholder. The numbers in square brackets show the extent of mutually-cooperative citizen science initiatives among stakeholders.

In more detail, we detected equal self-coordination either by Academia or NGOs, each stakeholder leads 14 CS projects (altogether represents 60% of all 46 CS projects), followed by public sector (only 2 cases), private sector does not individually leads no project. Mutual leadership between academia and NGO (7 projects) or academia and public sector (5 projects) shows quite satisfactory evidence of cooperation between stakeholders. Moreover, we revealed unique example of three party cooperation (NGO + public sector + academia). The relatively high level of cooperation between NGOs and academia indicates that academic organisations recognise the useful role of the non-profit sector. It values its connection to practice on the one hand, but also the willingness for public-science cooperation from the side of NGOs, as previously expressed by the Zelený kruh [Green Circle] (Čada, Ptáčková, and Stöckelová, 2009), which currently connects 27 NGOs. Moreover, these results contradict the relatively low evidence of NGO – science cooperation from recent European research of CS projects (Hecker, Garbe and Bonn, 2018), which showed the dominance of academia in leadership (45%), followed by educational organisations (14%), and with only 11% of projects led by non-governmental organisations.

4.4 Level of public participation in pure CS projects

An important aspect of CS projects is the level of public participation. Following Haklay's (2013) classification, we derived the following distribution of participation with respect to the Czech specific environment. Level IV of extreme citizen participation, based on mutual cooperation from the beginning and an open exploratory process, is represented by one unique case from the medical and health sciences with a strongly interdisciplinary character. The Level III of participatory science, characterised as mutual cooperation between various stakeholders, including scientists, was found in two projects (1 social science, 1 natural science).

Level II of distributed intelligence, in comparison, is widely represented in 35 cases, predominantly by the natural sciences (30), agriculture (2), social sciences (1), humanities and arts (1), and engineering and technology (1). This interpretation primarily corresponds to the natural sciences and monitoring in the field that requires advanced knowledge, time and some level of data interpretation. These efforts are required, for example, for the observation of the phenological phases of plants during the vegetation season, for meteorological monitoring, for observation of changes in bee colonies, for monitoring of plants and animals, for water quality and the environment. Finally, the Level I crowdsourcing includes various forms of simple data collection and reporting and was represented by 8 projects: the natural sciences (6) and social sciences (2). These activities mainly concern obtaining information and locations for special maps (e.g. animal accidents, the simple enumeration of single bird species occurrence, the location of events/objects, etc.). Table 1 briefly describes several representative examples of each level.

Level	Sum	Primary research area	Example		
			Name	Description	Coordinator
IV	1	Medical and health science ¹	Library for Brno without barriers	A highly interdisciplinary project based on a participatory process from the initial stage, which involves various stakeholders from policymakers, academia, the public, and NGOs. The aim of the project is to collect experience and know-how from participants to approach various aspects of disability from a community point of view. The project wants to institutionalise a new scientific discipline of disability studies.	Public institution
III	2	Natural sciences, social sciences	Action Frog	The project is based on cooperation between volunteers, NGOs, public institutions and scientists. Volunteers and conservationists indicate risk areas for frogs during spring migration and contribute to rescue actions. They also provide valuable scientific evidence and fight for better protection of this endangered species.	NGO
II	35	Agriculture, natural sciences, social sciences, humanities and arts	InterDrought	The project deals with monitoring and resolving agricultural drought. Scientists gather additional data from more than 100 active reporters/farmers that are used to monitor and evaluate the impact of agricultural drought on soil, yields, etc.	Academia
I	8	Social sciences, natural sciences	Emotional mapping	Recording of emotions that emerge in relation to specific places in an urban setting. Acquired data serves urban planning needs and applications, as well as further scientific analysis.	Academia

Tab. 1: Levels of public participation (Notes: ¹ Medical science indicates the relation of the disability issue with medicine although the project is also connected to social science. Due to interdisciplinarity, is difficult to strictly indicate the primary research area. Translation: Knihovna pro bezbariérové Brno [Library for Brno without barriers], Akce Žába [Action Frog] InterSucho [InterDrought], Pocitové mapy [Emotional Mapping]. Source: authors' research

4.5 Evolution of pure CS projects over time

Finally, we analysed the duration of Czech citizen science projects. The first CS project was initiated in 1954 (Český Hydrometeorologický ústav [Czech Hydrometeorological Institute], volunteer meteo-station service) and other long-lasting projects are also historically linked to the natural sciences, particularly ornithology. In Figure 5, we can clearly observe an extremely large increase in CS projects in the new millennium (since 2005 in particular), which corresponds to the recent expansion of information technologies and mobile applications. Most of the projects have been constantly running since their initiation. Only six projects appeared to be inactive in 2019, which probably indicates they have been terminated. One of those projects is in the stage of preparation and will be launched in 2020.

We can explain the long tradition of CS projects in the Czech Republic by the long-term history of various amateur associations and popular volunteer observation of the natural environment that provides vast amounts of valuable scientific data, leading to high-quality scientific outputs (e.g. Diblíková et al., 2013, 2019). Besides the long duration of these projects (especially ornithology and meteorology), another reason could be a need for non-conflictual social activities during the socialist regime (Vaněk, 1996; Tóth et al., 2018). On the other hand, most recent projects result from international cooperation, where a foreign project is adopted and adapted for the Czech environment.

4.6 The “potential” of potential CS projects

The 27 projects outside of the “pure” CS projects, i.e. those that did not meet any aspect of pure CS project definition but did represent some potential for further elaboration, are discussed in this section. In terms of a stricter definition of citizen science (Haklay, 2013), these were primarily first-level projects known as crowdsourcing, i.e. projects where public participation is realised through data collection. What connects most of these projects is that they do not designate themselves as CS projects, and they do not aspire to ‘pass on’ the results of their work outside their own community.

The main mission of these projects is to form or maintain a community and its environment, social environment or cultural heritage. If the results of their work are used for something, it is only for the purposes of the community, and perhaps for local or regional administrations. Their goal is not to perform or participate in science but to care for their own community. This character of these CS projects corresponds with the “more or less intensive public engagement” with NGOs (Krajhanzl et al., 2015; Krajhanzl, Chabada and Svobodová, 2018).

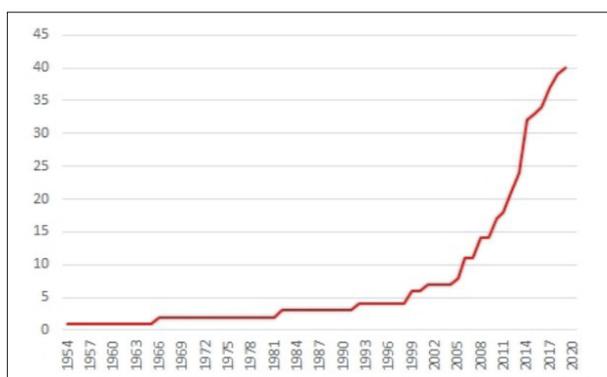


Fig. 5: Pure CS projects in the Czech Republic (1954–2019). Source: authors’ research

In terms of coordination, there was a prevalence of the non-governmental sector (16 cases), followed by public institutions (7 cases), with a low representation of the private sector (3) and academia (1). This indicates a significant flourishing of civil society and the non-profit sector, which goes hand in hand with highly evolved social and environmental movements. These findings show that public engagement has already overcome previous difficulties in civil society development, as described by several authors after the breakup of the socialist regime (Fagin, 2000; Vaněk, 1996; Císař, 2008).

Although these projects do not meet the strict definition of “pure” CS projects, they can satisfy the less stringent definitions of socially-focused authors (Joy et al., 2011; Purdam, 2014; Kimura and Kinchi, 2016; Mahr et al., 2018) and namely geoparticipation (Pánek et al., 2014; 2017; Pánek, 2016). In this context, it is interesting that while natural sciences dominate the set of “pure” CS projects, this is not the case for “potential” CS projects: 16 of which can be described as closer to the social sciences (see Tab. 2).

In terms of the thematic focus of “potential” projects, the largest group relates to social geography, such as transport, safety, and quality of the urban environment, “fix-my-street” or preservation of historical heritage and other issues connected to urban planning or community, which represents nearly half (16) of all potential CS projects. These projects usually focus on improving various forms of mobility, problem fixing and enhancing public space. The second largest group is constituted by projects dealing with ecology, sustainability and care for nature and the environment (8). These are projects that map various sources of air pollution, heat in city islands, places of sorted waste or bio-waste, protected areas, etc. The agricultural (or gardening issue) is represented by three examples. A short summary of all topics is provided in Table 2.

5. Discussion and concluding remarks

As previously mentioned, this project did not aspire to provide a complete set of CS projects in the Czech Republic. The exploratory character of the study, using several step-searching methodologies, facilitated the process of uncovering the hidden citizen science landscape and its heterogeneity. This exploratory phase enabled us to compile our own database of more than 70 CS projects, and further to distinguish between “pure” CS projects (N = 46) and “potential” CS projects (N = 27). Thus, in answering the general research question: “What types of projects meet the definition of citizen science in the Czech Republic?”, we found nearly 50 cases of pure CS projects, which more or less corresponded to established citizen science definitions.

To fulfill the general goal of the study to “Describe the heterogeneity of CS projects in the Czech Republic”, we continued with a further analysis of CS projects in the database. The first dataset was analysed in more depth, while for the second group we used shorter summaries. This does not mean that the second group is “second-rate” or “worse”. On the contrary, it is of particular analytical interest when it shows us the limits of universally understood definitions of citizen science. Moreover, the division between these two groups is not strict and the boundary is very thin.

We did not discover any significant differences in terms of general understandings and conceptualisations of citizen science in the Czech environment, compared to similar research in other countries, such as Hecker, Garbe and

Primary research area	Topics	Sum	Example		
			Name	Description	Coordinator
Social sciences	Transport Safety Waste Management Fix My Street Historical Heritage	16	Pedestrians for themselves	A web portal that seeks to improve the environment, ensure traffic safety, promote sustainable mobility and increase the accountability of citizens and public institutions regarding these issues. It enables community prioritisation of collected incentives by simply “liking”.	NGO
Natural sciences	Care for the environment and nature Animal protection Quality of public space	8	Ecomap: your eco-friendly navigation	Mapping of various eco-objects. The main categories are Eco Consumer, Waste, Nature, Organisation, Objects, etc. (specifically green shopping, farmers markets, waste separation, protected areas, wells).	NGO
Agriculture	Gardening Food	3	Gengel	Efforts to preserve old, regional, family and similar varieties of agricultural plants as a common cultural heritage. Gengel offers these varieties to the public so that they can become acquainted with them, cultivate them, use their fruits, share seeds and care for their future destiny.	NGO

Tab. 2: Examples of potential CS projects (Notes: Translation: *Chodci sobě* [Pedestrians for themselves], *Ekomapa: vaše ekologická navigace* [Ecomap: your eco-friendly navigation]). Source: authors' research

Bonn (2018) or the literature review by Kullenberg and Kasperowski (2016). We note only a different temporality in citizen science monitoring. Proper fully evaluated evidence is still missing, however, such that this study is the first step in remedying this gap in our understanding of the phenomena.

Our investigation has indicated a prevalence of the natural sciences (80%) as the primary research area, followed by social sciences (9%) and agriculture (4%). The highest proportion of projects was linked with ornithological research and indicated a long tradition of working amateur associations. The results are similar to the findings of Hecker, Garbe and Bonn, (2018) and the Bio Innovation Service (2018), indicating the predominance of nature and biodiversity monitoring. In addition, the prevalence of crowdsourcing or distributive intelligence is in accordance with similar research elsewhere (Haklay, 2013). In opposition to other similar research (Hecker, Garbe and Bonn, 2018), however, but in accordance with the results of the Bio Innovation Service (2018), we discovered a high level of NGO coordination in the Czech Republic.

An interesting finding revealing the heterogeneity and diversity of CS projects was recorded by the comparison of pure and potential CS projects. While the first (“pure”) group is more linked to the natural sciences and citizens mainly help by increasing scientific evidence (Kullenberg and Kasperowski, 2016), potential CS projects are closer to the general idea of participation and community work, and aim to improve public space or the environment, or rather social science objectives (Joy et al., 2011; Purdam, 2014; Kimura and Kinchi, 2016; Mahr et al., 2018) and are related to the “democratisation” process in science (Mahr et al., 2018). It is clear that, in the Czech Republic, the social sciences have a significantly higher occurrence among the “potential” CS projects than among the “pure” CS projects. While the natural sciences are more involved in implemented CS projects, the social sciences are more represented among potential CS projects. This implies a significant question: “Why are the social sciences less represented in the dataset

of pure CS projects?”. The question remains, moreover, as to whether this is as a result of the slower penetration of citizen science into the social sciences, or, conversely, of an inappropriate definition for CS, which mainly fits the natural sciences. Regardless, it is clear that citizen science in the Czech Republic has a different meaning for the social sciences than for the natural sciences. While natural sciences understand citizen science as a fundamental tool for building a relationship between scientists and the public, social sciences do not feel this need, as they are always linked to society through their subject of interest.

Social science “makes” science with people about people, is not dependent on complete datasets, and finally, more often uses qualitative methodologies that make it appropriate for even small data sets. The key question then is not: “Why are the social sciences less represented in the group of pure CS projects?”, but rather: “What could be the benefit of citizen science for the social sciences?”. Kingsley Purdam (2014) uses an example of “citizen social science” to answer this question. He offers examples of blogs and websites where people can share their experiences (e.g., sexual harassment) or observation by trained citizen scientists of their daily activities or everyday trips (identifying begging). Purdam himself defines a fairly comprehensive list of disadvantages (the need for training citizen scientists, limited validity checks, the difficulty of obtaining demographic data, the different terms and language used by citizen scientists, the very limited depth of collected data, the ethical problem of collecting data on other people, etc.) that do not show the use of citizen science in the social sciences in a particularly good light (Purdam, 2014, pp. 383–385).

In contrast, we note that social science has already the tools created for this purpose (field records, field diaries, diary records, activity travel-diaries, etc.). Other authors have attempted to answer this question by looking for examples in the collaboration between citizen science and Science and Technology Studies (STS). According to their examples, however, STS does not understand citizen

science as a natural science, i.e. as a tool for achieving “other” results. Instead, STS understands citizen science as a subject for research, in which they essentially do not participate but merely critically evaluate it (Mahr et al., 2018; When et al., 2015).

Our answer to this question is, therefore, quite different. In agreement with Bálint Balázs (2019) and his concept of “invisible citizen science”, we are addressing “hidden” citizen social science in two distinct ways: firstly, citizen social science in the Czech Republic was hidden in post-socialist space; and, secondly, it has been hidden by the demands of the natural sciences. Social sciences need and also use citizen science, but for other purposes than the natural sciences. Therefore, the form of citizen science in the social sciences cannot match the definition of pure citizen science projects, so its occurrence is under-represented in this part of our database. One of the most analytically interesting results of our research is actually our response to the question: “How to make citizen social science more visible in post-socialist space?”.

Our answer to this question is twofold. The first concealment is the invisibility of citizen science, as Balázs (2019) points out. In this sense, further mapping of CS projects in individual CEE countries is helpful, especially when very little evidence of CS projects from these countries was indicated in most of the international studies or repositories (Bio Innovation Service, 2018; Hecker, Garbe and Bonn, 2018). Our study points out that the reality of a CS project in the CEE geographical region might be different or even distorted from how it is presented. First, a lower representation of a non-English CS project might be caused by language barriers, appositely mentioned in the study provided by Bio Innovation Service (2018). Second, the lower internal and subsequent international activity of the mentioned countries is monitored, as indicated by Hecker, Garbe and Bonn (2018), as a small number of responses. To rearrange this imbalance, more intensive international cooperation with non-English speaking countries and especially CEE countries is needed.

The second concealment is given by the desire to universally define citizen science for all sciences based on the needs of only the natural sciences. The solution to this concealment outside the definition and vice versa, is to increase the visibility of citizen social science in society by (i) abandoning the idea of a common definition of citizen science for all sciences, and (ii) allowing different definitions of citizen science for different sciences. In other words, to apply a more open and heterogeneous approach, as Niewöhner (2016) suggests. In practice, this may mean some or all of the following approaches: focusing on participation that is not limited to data collection; selecting citizen scientists intentionally, not randomly; a greater use of self-research approaches (autobiography, auto-ethnography, etc.); and finally, selecting different thematic areas of research (such as community emancipation, forms of resistance or organised disobedience, research on mental health, loneliness, stigmatisation, etc.).

Above all, another potential avenue for the future might be to extend the definition of citizen science to include organisational, administrative and genuinely community-based ways of participation, as presented in the section above on “potential” citizen science projects. This means embracing projects whose primary objective is not to “generate scientific knowledge” but to “generate knowledge useful for the community” (participation in a variety of administrations, management, coordination – flood management, water

management, waste management, defect management, barrier management, etc.). Such projects would then be part and parcel of modern Critical Geography.

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Data accessibility

The data that support the findings of this study are available from the authors, with a further detailed expression of interest in their use as well as a reasonable request.

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Websites of organizations and projects discussed in the paper:

- Arnika: <https://arnika.org/>
- Centrální evidence projektů [Central Evidence of Scientific Projects]: <https://www.rvvi.cz/cep>
- Český Hydrometeorologický ústav [Czech Hydrometeorological Institute]: <http://portal.chmi.cz/>
- Chodci sobě [Pedestrians for themselves]: <https://www.chodcisobe.cz/>
- Czech Academy of Sciences: <http://www.avcr.cz/en/>
- Děti Země [Children of the Earth]: <https://detizeme.cz/>
- Ekomapa: vaše ekologická navigace [Ecomap: your eco-friendly navigation]: <https://www.veronica.cz/ekomapa#>
- Frank Bold: <https://frankbold.org/>
- Gengel: <http://gengel.cz/>
- Hnutí DUHA [Friends of the Earth Czech Republic]: <http://www.hnutiduha.cz/>
- InterSucho [InterDrought]: <https://www.intersucho.cz>
- Knihovna pro bezbariérové Brno [Library for Brno without barriers]: <https://www.kjm.cz/knihovna-pro-bezbarierove-brno>
- Nadace Partnerství [Environmental Partnership Foundation]: <https://www.nadacepartnerstvi.cz/>
- Nadace Veronica: <https://nadace.veronica.cz/>
- Národní úložiště šedé literatury [National Repository of Grey Literature]: <https://nysl.cz/?language=en>
- Pavučina [Network of Environmental Education Centres in the Czech Republic]: <http://www.pavucina-sev.cz/rubrika/77-ENGLISH/index.htm>
- Pocitové mapy [Emotional Mapping]: <https://www.pocitovemapy.cz>
- Souborný katalog České republiky [Union Catalogue of the Czech Republic (CASLIN)]: https://aleph.nkp.cz/F/?func=file&file_name=find-b&local_base=skc&CON_LNG=ENG
- Zelený kruh [Green Circle]: <http://www.zelenykruh.cz/en/>

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