Engaging heritage communities by citizen science – Considerations, experiences and lessons learnt

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Abstract

The diversified formats of citizen science provide new possibilities for initiating heritage communities. The authors understand the conference theme in a broad sense and follow the concept of citizen science as advocated by Pettibone & Vohland (2016).

The focus is on three citizen science projects in Austria that have had an impact on diverse communities: The annual Geo-Day of Nature works with lay researchers, which not only significantly increases species records, but also creates an active and supportive community. The project, Flora@Velden.eu, investigates and discusses native and non-native plants with pupils in the context of human migration. Game of Clones is a strategy game for site management that was developed with scientists and students.

These experiences suggest that the involvement in scientific activities can trigger the identification of a community with a certain topic, question or site. Lively communities need a purpose and the contribution to science can be one.

Keywords

citizen science, biosphere reserve, Natura 2000, introduced species, community involvement

Introduction

Citizen science – Emerging research designs to activate the intelligence of the crowd

According to the GEWISS definition (Pettibone & Vohland, 2016: 6), "citizen science describes the engagement of people in scientific processes who are not tied to institutions in that field of science". Concepts and research designs involving citizen science are used in diverse disciplines, most often in natural[8] and social sciences with an emerging trend in medicine[9] (Oberle & Page, 2019). The involvement of lay researchers may range from simple data collection to the most sophisticated trans-disciplinary research activities, including the development of research questions or the analysis and dissemination of results (Dörler & Heigl 2018; Dörler & Heigl 2019).

Pettibone & Vohland (2016) argue that citizen science generates multiple benefits for science, society and also for participants. The manifesto

[8] Examples: https://ebird.org/home; https://www.naturbeobachtung.at; www.citizen-science.at;

[9] Examples: www.migraene-radar.de; www.pollenwarndienst.at/allergie/pollentagebuch.html;

on Citizen science 3.0 (Lukyanenko 2019:2) considers citizen science "a socially valuable and important movement which stands to bring extensive and diverse benefits to the scientists, the organisations, the citizens and the society at large". However, citizen science may lead to significant identification with the research topic, to widely accepted, socially robust results, and opens up new research opportunities. Moreover, citizen science has proven to be a powerful instrument for educational purposes, for instance in the interpretation of heritage.

Heritage community – Connecting to a *genius loci*

"[Heritage] Interpretation enriches our lives through engaging emotions, enhancing experiences and deepening understanding of people, places, events and objects from past and present." (AHI Association for Heritage Interpretation 2018). Whether intended or not, this definition of heritage interpretation has a visitor perspective. It is aimed more at tourists, guests and interested individuals from outside the region than at local stakeholders, landowners and communities. Heritage interpretation has its roots in US national and nature parks, and its goal is to improve and enrich the experience of visitors to certain sites by helping them understand the significance of the place (Tilden 1957; Ludwig 2014).

In literature and scientific discussion, 'heritage communities' are mainly discussed in the context of cultural heritage, both tangible and intangible. A particularly relevant reference is the Convention on Intangible Cultural Heritage (2003), which recognises that "communities, in particular indigenous communities, groups and, in some cases individuals, play an important role in the production, safeguarding maintenance and recreation of the intangible cultural heritage". The convention remains vague on the definition of a 'heritage community' but gives an inherent indication that such a community will be found mainly at local or sub-regional level.

It is widely accepted in scholarly discussion that "the recognition of the value of cultural, social, environmental, economic 'resource' of a heritage by the communities is a decisive step to strengthen social cohesion, improving the quality of life of the population and triggering economic development processes" (Pinto *et al.*, 2019).

Various authors, such as Macmillan (2016), point to the broad and diverse meaning(s) of heritage communities, which even include nations, states and legal systems. Macmillan's observation that "it seems that the central foundational concepts around which community rotates are identification and memory" (Macmillan 2016:5) may be helpful.

In this article, the authors aim to describe, explore and discuss the relevance and potential for community involvement in the preservation of *natural* heritage.

Natural heritage – Communities in conflict and support

Natural heritage sites worthy of protection can range from small-scale features such as a geological formation, a particular specimen´s habitat or an ancient tree, to whole river-systems, large areas of primeval forests, mountain ranges and other wild and cultural landscapes. Somewhat different to cultural heritage, the preservation of natural heritage often also has implications for land use and livelihoods. These may be positive or negative, they may be overestimated and used for political agitation, they may be imposed by law or on a voluntary basis, but they cannot be denied. Hence, in most cases, the establishment and management of natural heritage sites requires debate with stakeholders, resulting in acceptance and support for the concepts and measures of conservation. There are common, well established processes for community involvement in conservation sites (e.g. IUCN 2013).

In particular, conservation sites as advocated and recognised by UNESCO have a particular emphasis on a strong interconnection with local communities, since these sites are based on the global principles of UNESCO and the United Nations Sustainable Development Goals.

Three categories of UNESCO sites deal with natural heritage. One of these is biosphere reserves; currently some 701 sites in 124 countries are considered to be "learning sites for sustainable development"[10]. Equal in status to cultural sites, UNESCO´s natural World Heritage Sites represent sites of "outstanding universal value"; currently, 213 of these sites in 96 countries are registered on UNESCO´s world heritage list[11]. Lastly, the network of geoparks comprises 147 sites in 41 countries.

The implementation and management of these sites is usually carried out in parallel with educational and scientific activities and programmes. These efforts create collectives that also involve local communities but can go far beyond them. Great importance is attached to ensuring that these sites ae useful and supportive to local stakeholders. Using the example of the Lenggong World Heritage Site (Malaysia), Ahmad *et al*. (2017:21) state that the "residents' perceptions of WHS can be divided into two dimensions, namely perceived benefits and perceived costs". Taking the Italian Abruzzo region as an example, Colecchia (2019:153) argues that through "stakeholder participation and involving local communities, the parks give them the opportunity to develop cohesive partnerships and to create innovative local enterprises and new sources of revenue".

Projects and examples

In the following pages, we present three projects that show how citizen science can contribute to the development of heritage communities. The examples explore citizen science from different angles and identify citizen scientists as students, lay researchers or local people. In all three projects, the heritage is the indigenous biodiversity. The community is formed by the citizen scientists and by local people who care about nature conservation in the 21st century.

GEO-Day of Nature – Experts and nature enthusiasts in search of animal and plant species

The GEO-Day of Biodiversity (now GEO-Day of Nature) is a field research day, which has been proclaimed annually by the GEO magazine since 1999. On one early summer weekend each year, experts and nature enthusiasts in Germany and neighbouring countries swarm out to discover which animal and plant species live in forests, fields and riverbanks, but also in metropolises, cities and communities. The aim is to draw attention to the diversity of species right on our doorstep. The GEO-Day of Nature is one of the largest field research events on biodiversity in Europe and creates awareness of the entire highly sensitive system in which we live and calls on people interested in nature to take concrete action.

The heritage is the biodiversity examined during the events, the community is formed by the experts and people interested in nature who work together voluntarily for a good cause. In

[10] http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/ (accessed: March 2020)

[11] https://whc.unesco.org/en/list/?type=natural (accessed: March 2020)

Carinthia, the 4th GEO-Day of Nature took place in 2019 in the Nockberge Biosphere Reserve. The field research day makes a significant contribution to the documentation of species in the 480sqkm biosphere reserve (Glatz-Jorde *et al*. 2017, 2018). The citizen science event enables nature-loving citizens and young researchers to participate in scientific field research in the form of guided excursions and joint debriefing.

Figure 1. As part of the GEO-Day of Nature, experts and nature enthusiasts collect and document as many species as possible within 24 hours. In this way they make a significant contribution to the preservation of the heritage of the Nockberge Biosphere Reserve and meet like-minded people (Photo: Ch. Komposch, ÖKOTEAM, 18.05.2019)

Figure 2: One of the highlights, which can already be described as traditional, is the evening sorting of the soil sample under the spotlight. Here, experts and nature enthusiastic citizen scientists can exchange views once again and lay people can expand their knowledge of the native biodiversity in the Biosphere Reserve. Photo: Ch. Komposch, ÖKOTEAM, 17.05.2019

After the research days in 2018 were held in the middle and high altitudes of the Nockberge Biosphere Reserve (Glatz-Jorde *et al*. 2017, 2018, 2019), the 4th GEO-Day of Nature took place in the valley area on the eastern shore of Lake Millstättersee. As every year, the participants tried to find as many species as possible within 24 hours, which were then jointly identified and documented. Using a wide variety of methods, consisting of photographs, visual observations, hand catches by day and night, the bottom sieve, landing net and lighting equipment, a total of at least 1,166 species were identified. The spectrum was distributed across 457 vascular plants, 88 mosses, 112 fungi, 103 lichens and 406 animal species. The fauna was further subdivided into 257 insect species (and five Apterygota species), 53 arachnid species, four crustacean species, ten mollusc species and 73 vertebrate species. The event was also combined with an ABOL-BioBlitz-Action, which, in cooperation with colleagues from the Natural History Museum Vienna, made use of valuable synergies and contributed to the population of the Austrian DNA reference database.

In order to strengthen the citizen science aspect, the Centre for Natural History (CeNak) of the University of Hamburg, the Loki-Schmidt Foundation, and the GEO-Day of Nature have launched a citizens' action for an intact environment at *artensuche.hamburg*. The project enables citizens to get involved in the field of citizen science for biodiversity and to conduct field research throughout the year. They can help to document animal and plant species over a longer period using their smartphones and thus collect knowledge together. In a first step, the cuckooflower (*Cardamine pratensis*) and the Chinese mitten crab (*Eriocheir sinensis*) were proposed for the search (geo-tagdernatur.de).

These voluntary geographical information (VGI) activities and the crowdsourced geoinformation in citizens' projects help scientists, political decision-makers and companies to design and introduce new scientific projects. These tools represent a new opportunity to launch research projects using widely available ground data, including the monitoring of natural, ecological, man-made and social changes and events (Bordogna 2018: 1). In these contexts, VGI appears to be a relevant aspect of citizen science. Nevertheless, the collection of VGI, the filtering of crowdsourced geoinformation and its analysis implies the adoption and application of geoinformatics techniques first developed for the management of traditional geodata in GIS environments. Therefore, the appropriateness, coverage, adaptability and completeness of traditional geoinformation technologies for the management of VGI and crowdsourcing information in civic science deserve investigation.

The GEO-Day of Nature is, therefore, a pleasing symbiosis between experts and nature enthusiasts. On the one hand, valuable data is collected, which is necessary to preserve the heritage of the Nockberge. For example, despite suboptimal weather conditions, 30 bee species were counted, the highly endangered green lizard was observed, a species of harvestman (*Trogulus tricarinatus*), which is new to the biosphere reserve, was found and 13 species of fish could be observed in close proximity. It is only through this collection of data that the heritage becomes tangible. On the other hand, in 24 hours, the expertise of all participants is assembled to work on an important topic and that welds together. Experience also shows that the professional and hobby researchers will come back the following year to work together on this project.

Flora@Velden – Children explore plants in their school environment

The children and young people who attend the schools and kindergartens in the Austrian municipality of Velden come from the most diverse regions of our earth – just like the plants that occur around the schools. Based on this idea, the market town of Velden developed a LEADER project and entrusted ECO Institute of Ecology with detailed conception and implementation. The EU funding programme LEADER is intended to support the rural regions of Europe on their way to independent development and strengthening.

In the project, Flora@Velden.eu – Education inclusive, kindergarten and school children learned about the plants of the school environment and their areas of origin. They also learned a lot about the needs and the use of these plants and how and under which circumstances they had come to our area. The example of the plants should give the young people the opportunity to address and discuss challenging topics such as migration, integration, inclusion and diversity, supported by teachers and experts with different professional backgrounds.

The teaching of the contents was interdisciplinary, cross-school and across age groups. The students learned to know and appreciate the natural heritage around their school, disregarding their origin. So, the heritage community, the children, the newcomers and those who have always been there, grew together. Each child was responsible for a plant; for tending it and finding out everything they could about it, the bond with nature growing around it. In order to increase the citizen science element of the project and include the knowledge of the local population, the children interviewed their parents, siblings, aunts, uncles, neighbours, acquaintances and friends to find out what they knew about their plant.

In the course of the project, the participating pupils could discover that many plants, which they had previously taken for granted as part of the local landscape, originally came from completely different regions of the world. Without these migrating plants, our daily menu and the appearance of our fields and meadows would look completely different. The children learned that the plants from different countries of origin have often had an eventful history, and this mirrors the history of themselves and their families and ancestors. In this context, diversity in the plant world and in their own environment could be linked to a positive feeling.

Figure 3. In the project, Flora@Velden.eu – Education inclusive, kindergarten and school children learned about the plants of the school environment and their areas of origin. One of the realisations was that the plants from different countries of origin have often experienced an eventful history, just as the participants themselves have (Photo: A. Fuchs, E.C.O., 22.05.2017)

The most important learning goals are summarised:

- Teaching scientific contents and knowledge of the local flora
- Raising awareness of the issues of inclusion, diversity and migration
- Recognition and positive experience of diversity in one's own environment
- Raising awareness and discussion opportunities with students, teachers and scientists on the importance of diversity in schools and the surrounding flora
- Awakening interest in the confrontation with other cultures.

The contents were taught in five units of two-to-four hours each. Three of them took place in the classroom, one unit each in the school environment and in the Carinthian Botany Centre in Klagenfurt. The basic programme in all school classes included theoretical inputs, interactive and practical learning using wild and cultivated plants, world maps, discussion groups, excursions and working with a plant press. The kindergarten children also carried out additional activities in cooperation with the Assisted Living institution in Velden.

Figure 4. Each child was assigned a plant, which they tended and researched. Becoming aware of the richness of the surrounding meadows, the children exchanged ideas about 'their' plants (Photo: A. Fuchs, E.C.O., 12.06.2017)

The programme was individually tailored to each age and school level. The different school locations and the different periods of implementation of the teaching units in the field (April to September) resulted in the collection of a wide range of plant species. It ranged from spring bloomers to summer plants and late bloomers. The final unit – the cooperation days – was the same for all schools and was intended to bring together the different schools and age groups and at the same time to refresh the contents that had been worked out.

Game of Clones – Students model the dispersal and fighting of Japanese knotweed

Due to the constant movements in the plant world, the question whether a plant species is native to a region or not can often not be answered so easily. One approach is to divide them into indigenous, archaeophytic and neophytic plants. Indigenous species are plants which have developed in the current distribution area or have migrated there without human influence. These processes took place before the last ice age. Plants which have been long-established in an area – probably after being introduced into a new area with agriculture by direct or indirect human influence and have then independently reproduced – are called archaeophytes.

The Central European archaeophytes originate to a large extent from the Mediterranean region and the bordering areas of Western Asia. Among them are many plants that are familiar to us such as cultivated apple, pear and plum, cereals such as wheat and barley, or flowers and officinal plants such as corn poppy, cornflower and true camomile. Many archaeophytes have become rare today due to intensification or abandonment of land cultivation. The heritage of these native plants is threatened not only by direct human influence but also by plants introduced by humans.

Plants which colonised a new area after 1492, when Christopher Columbus arrived in the New World and the Columbian interchange (widespread transfer of plants, animals, culture, diseases, etc.) began, are called neophytes (from the Greek for 'new' and 'plant'). Examples are potato, paprika, corn, tomato and pumpkin that were brought to Europe. There have also been and still are numerous unintentional disappearances as a side effect of global trade. Some of the neophytes are characterised by adaptability and high reproduction rates.

The Japanese knotweed (*Fallopia japonica*), a plant originally native to Asia, was able to spread rapidly in North America and Europe within a few decades. The species is very adaptable and competitive. Once it takes root, it reproduces vegetatively and forms dense stands of up to four metres in height without undergrowth. Even tiny fragments are enough for the plant to regenerate and form rapidly growing *Fallopia* clones. There is no consensus among conservationists, representing the heritage community, as to which control approach promises the most success in curbing the growth of the plant. Subsequently, a team of scientists and high school students made this the focus of their research project, Game of Clones.

The aim of this Sparkling Science project, which ran from 2016 to 2019, was to investigate spatial models of the spreading behaviour of knotweed under different conditions. To pursue this goal, a vast understanding of knotweed, especially regarding its ecological optima, its dispersal strategy and its response to different control measures was necessary.

For answering some of the open questions, experiments were used. Investigations in two reference areas (the Natura 2000 sites Lendspitz-Maiernigg and Obere Drau) and various field experiments, which were carried out by the students partly with guidance and partly independently, helped to develop and supplement the model. Among other things, the complete rhizome network of a population of Japanese knotweed was uncovered in order to better understand the relationships between above-ground and underground plant growth.

Figure 5. In the Sparkling Science project, Game of Clones, students and experts work together: over a period of two years. They research *Fallopia japonica*, the Japanese knotweed, test control strategies against it and carry out experiments and monitoring (Photo: H. Bauer, 23.10.2019)

In experiments with rhizoboxes, the rhizome growth was observed under different conditions. A total of 95 DNA samples were collected to obtain information about its hybridisation. All results and experiences were taken into account in a NetLogo simulation of Game of Clones. NetLogo is a simple programming language but has all the scientific requirements and all the technical prerequisites to implement an adequate model. It is, therefore, suitable for use in school lessons. The model created in the project simulation is not intended as a final model but it provides the pupils the opportunity to develop and change it further. The topic of simulation has potential for use in various subjects, including biology, mathematics, geography and computer science (Fuchs *et al*. 2020).

Furthermore, the research results form the basis for the Game of Clones strategy game, which is available both as a board game and as an online game (https://game-of-clones.itch.io). The game board shows a landscape composed of habitats of varying suitability for Japanese knotweed and some randomly distributed clones of the plant. Together, the players try to take measures against the knotweed to make the clones disappear and to keep the nature conservation areas free of them. In several test rounds, the players started to realise how fast Japanese knotweed can spread and what little can be done about it, if it is not managed effectively early on. The only way is to cooperate, to combine control measures and to act as quickly as possible. Whenever the population is small, it is still quite easy to manually remove the plants one by one, but once the board is mostly overgrown by knotweed, it is extremely hard to push back the plant.

The game is designed to mimic reality as closely as possible and, in terms of controlling knotweed, it shows that mechanical methods are time-consuming and inefficient, and that herbicide and weed control foil are more efficient but are expensive in terms of long-term consequences. In this way, Game of Clones creates awareness of invasive species and possible strategies against them in a playful way. Besides that, the students from the research team were able to take home a lot from the process. By being able to participate in the experiments and the development of the board game, they learned a lot about invasive alien species and simultaneously enjoyed the feeling that they were making an important contribution to science and education(Fuchs *et al*. 2018).

The board game can also be backed up with real aerial photographs. In this way, experts and affected parties (e.g. agents from nature conservation, administration, agriculture and construction site management) can develop solutions in a workshop for areas where the occurrence and spread of Japanese knotweed is seen as problematic. In doing so, they also get to know the interests and problems of the other participants and can negotiate their positions away from a real conflict. In the best-case scenario, a common strategy for control of *Fallopia* is available at the end of the workshop day.

Figure 6. The research work led to the cooperative strategy game, Game of Clones. The participatory development process and numerous test rounds with the students ensured a balance between realism and playability. The aim of the board and online game is to use various control measures to keep the plant in check (Photo: M. Jungmeier, 27.06.2012)

Conclusions and further perspectives

Our experiences with different formats of citizen science suggest that action research and other types of citizen science can be interesting elements for initiating and activating heritage communities, for cultural and natural sites as well. These experiences suggest that the involvement in scientific activities can trigger the identification of a community with a certain topic, question or site. Lively communities need a purpose and the contribution to science can be one.

Citizens science can support the process of intellectual and emotional empowerment. It can activate the intelligence of the crowd, demystify science and lead to the equitable inclusion of people without academic training. The motivation to engage in citizen science is a special quality of the site, which McGreavy *et al.* (2017) call the 'power of place'. Various scholars agree on the "importance of protecting and enhancing the identity values of the places to contribute both to the creation of a heritage community and to the strengthening of the community resilience" (Pinto *et al*. 2016:1).

In some cases, we acknowledge that citizen science cannot be clearly separated from mere social research and educational formats. With reference to a classification of different types of citizen science, as discussed by Dörler & Heigl (2019), four intensities of public involvement in the research process can be identified: crowdsourcing, distributed intelligence, participatory science and extreme citizen science. In the context of heritage communities, participatory science and extreme citizen science are perhaps most important. These formats are challenging for scientists, but also require qualified counterparts in civil society.

The participatory approach was particularly strong in Game of Clones. Experts and students were able to develop a project and measures together to help preserve the natural heritage. In Flora@Velden, pupils and their neighbours became involved with their environment and were able to appreciate it more. On the GEO-Day of Nature, it was mainly crowdsourcing, where experts and nature enthusiast could devote their attention to the biodiversity of a region for 24 hours.

As in other sectors, the platform will play a major role. Citizen science platforms of the future should no longer be merely "data harvesting platforms" (Lukyanenko 2019:2), but open data repositories that allow for diversified uses and analysis. This can pave the way for future heritage communities to answer their own questions, analyse available data in various ways, and become the shapers and owners of the research process. This should be "predicated on free and open participation, removal of participation barriers, intensive active data sharing and use of innovative artificial intelligence technologies" (Lukyanenko 2019:2).

Special attention will be paid to a new research ethic. It should be ensured that citizen science is not based on the unrewarded and unrecognised exploitation of volunteers and unpaid labour. The formats of joint research require a sophisticated mastery of intellectual property rights and a fair share of resources, recognition and results. In this context, Vohland *et al.* (2019:1) made considerable reflections on "the economisation of knowledge, economic criteria for evaluating research, and a retreat of the state from governance of the scientific system".

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