CS TRACK
Investigating Citizen Science

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Conceptual Framework for Analytics Tools

D1.2

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Executive summary →	Building upon Deliverable D1.1, Deliverable D1.2 goes beyond the report in several respects. Firstly, it presents a mapping of citizen science landscapes in the European Union and beyond, of funding programmes, policies, advocacy and working groups, and opportunities for participating in citizen science activities. Resulting from desktop research and expert interviews, this mapping also presents findings on geographic areas such as Russia that are usually not in focus when talking about citizen science. Since the issue of political contexts was not addressed in Deliverable D1.1, it is addressed in this report

	in an exemplary way. Secondly, interviews with African, Asian, European and US-American experts on Open Science, research ethics and research integrity supplement the literature review for Deliverable D1.1 and allow to get a clearer picture of potential policy options here. Thirdly, this report presents an overview of educational citizen science activities in schools that complements the literature review on citizen science activities in education. Chapter 2 of this report presents the methodologies for this report. Altogether, the research for Deliverable D1.2 consisted of literature analysis, web searches, and expert interviews. Chapter 3 presents analyses of citizen science landscapes in selected geographic areas. These analyses are based on a structured web information retrieval that is described in the methodology chapter. For some geographic areas either no information on citizen science in these areas could be found or there is no command of the official languages of these areas in the consortium. Consequently, the authors conducted interviews with experts on Open Science and citizen science in these geographic areas. Based on expert interviews, chapter 4 of this report discusses policy contexts of citizen science activities and issues of research ethics and research integrity of such activities. Chapter 5 gives the overview on citizen science-related educational activities in schools in Europe. Chapter 6 and 7 describe methodologies for Work Package 2, 3 and 4. Chapter 6 presents the binding force of the research methodologies in Work Package 2, 3 and 4: how they are related to each other, what methodologies are applied in these work packages, and, finally, how these methodologies have been revised when conducting the project. Chapter 8 of Deliverable D1.1 presented the role and context of computational analytics in CS Track and the methods to be applied for the analytics techniques to be performed in Work Package 3. Complementary to this description, Deliverable 3.1 presented the processing techniques Work Package 3 draws on and the different levels of analysis. In chapter 7 of this report these levels are further exemplified, furthermore, computational representations, methods of analytics and the operationalisation of indicators are described: the conceptual model underlying the structure of the database from which data are retrieved for web analytics in Work Package 3, attribution, the extraction of data, and the operationalisation of indicators. The report closes with notes on contributions (chapter 8), a bibliography (chapter 9) and an annex with the interview guidelines and handouts for the expert interviews.

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1 Concept and rationale

Michael Strähle & Christine Urban[1]

This report is Deliverable D1.2 of the research project CS Track which is funded by the European Commission under the Science with and for Society Work Programme. The aim of CS Track is to broaden the knowledge about citizen science and the impact citizen science activities can have. This overall objective is achieved by understanding and characterising citizen science activities so that one can say how they can be improved in terms of maximising their benefit for all participants and stakeholders, citizen and professional scientists, policymakers, and funders, while meeting scientific standards of validity and reliability, paying attention to caveats and potential pitfalls, and respecting research integrity and ethics. The CS Track consortium investigates a large and diverse set of citizen science activities, discusses good practices, and formulates knowledge-based policy recommendations to maximise the potential benefit of citizen science activities on individual citizens, organisations, and society at large.

As already stated in Deliverable D1.1, what the term "citizen science" refers to depends, among other things, on science cultures, research orientations, fields of research and the kind of citizen participation in the respective research activities (Eitzel et al., 2017; Kullenberg et al., 2016; Riesch et al., 2014; Heigl & Dörler, 2017). Among other activities, it can refer to crowdsourcing activities such as collecting weather data, to spotting animals in an online video, deciphering handwritten historic documents, solving scientific puzzles, or making experiments in your garden, but also to formulating research questions and even to setting research agendas, developing robotic prototypes or conducting practical science projects in schools. For the Science with and for Society Work Programme the European Commission offers a description of citizen science that includes activities ranging from school education through citizen participation in scientist-led research projects to fab labs and citizen engagement in science policy. In the framework of CS Track the consortium uses the explanation of citizen science the European Commission gives in the Science with and for Society Work Programme 2018-2020:

> *(…) citizen science should be understood broadly, covering a range of different levels of participation, from raising public knowledge of science, encouraging citizens to participate in the scientific process by observing, gathering, and processing data, right up to setting scientific agenda and co-designing and implementing science-related policies. It could also involve publication of results and teaching science.* (European Commission, 2018, p. 41)

The Science with and for Society call topic under which CS Track received a grant, and particularly the rationale of CS Track, aim at an integrated investigation of participation patterns; societal, democratic, and economic benefits of citizen science; incentives, disincentives, barriers, and enablers to involving and engaging citizens and scientists in citizen science activities. Equal access and absence of discrimination are important desiderata for this endeavour. This brings in the questions of social conditions for access, gender equity, and world-wide accessibility.

[1] Authors listed in alphabetical order.

The overall objective of Work Package 1, of which this report is a deliverable, is to investigate and consolidate the existing knowledge on citizen science by

-→ comparing and analysing various efforts that have already been made to categorise citizen science activities;

-→ identifying knowledge gaps, respectively open questions in relation to incentives, disincentives, barriers and enablers to the involvement of citizens and scientists; the types of activities conducted; participation patterns in citizen science; societal, democratic, economic and scientific benefits and potential caveats of citizen science;

-→ creating a conceptual framework for analytical tools and assessment procedures that consider the project objectives in relation to activities, size/ scale, funding, technical requirements (equipment) and visibility;

generating basic conceptual models for analyses to be conducted in Work Package 3;

and identifying exclusion criteria for the selection of citizen science activities that are further assessed in Work Package 2.

Moreover, Work Package 1 puts citizen science in EU Member States and Associated Countries into global and historical contexts.

For achieving the overall objective of Work Package 1 CS Track reviews scientific literature on citizen science, conducts expert interviews and analyses already existing ways/attempts to categorise citizen science activities.

Deliverable D1.1 presents literature reviews addressing a selection of topics listed in the Science with and for Society call topic description to assess the state-of-the-art on what is known about these topics according to peer-reviewed scientific literature and to identify knowledge gaps that could be filled in Work Packages 2, 3 and 4. These topics are:

- Historical contexts
- Conceptualisations and definitions of citizen science
- Benefits, caveats, and ethical aspects of citizen science activities
- Participation patterns, demographical and gender aspects
- Enablers, barriers, incentives, disincentives for the mainly involved persons
- Educational aspects
- Visibility of citizen science activities
- Economical aspects
- Categorisations and typologies of citizen science

Deliverable D1.1 also investigated how citizen science is analysed and what are the different forms of citizen science included in the conceptualisations, categorisations, and definitions of citizen science. This resulted in the Activities & Dimensions Grid of Citizen Science that categorises citizen science activities in detail, thus providing the basis for conceptual models to be applied in web analytics in Work Package 3. These models are generated from the categorisations.

Building upon Deliverable D1.1, Deliverable D1.2, goes beyond the report in several respects. Firstly, it presents a mapping of citizen science landscapes in the European Union and beyond, of funding programmes, policies, advocacy and working groups,

and opportunities for participating in citizen science activities. Resulting from desktop research and expert interviews, this mapping also presents findings on geographic areas such as Russia that are usually not in focus when talking about citizen science. As already mentioned before, there are quite different understandings of citizen science. These differences are inscribed in policies. Such differences may impact on citizen science landscapes. Since the issue of political contexts was not addressed in Deliverable D1.1, it is addressed in this report in an exemplary way. Secondly, a literature review on ethical and integrity issues in citizen science showed that such issues are discussed in citizen science (e.g., Resnik et al., 2015; Rasmussen & Cooper, 2019; Cooper et al., 2019; Jobin et al., 2020), however, sometimes quite generically (Haklay et al., 2020a & 2020b). Therefore, it was decided to conduct interviews with African, Asian, European, and US-American experts on Open Science, research ethics and research integrity to get a clearer picture of potential policy options here.

Thirdly, citizen science in education is a specific area of citizen science activities that differs from other areas of citizen science activities mainly in two respects: Participation in them is often compulsory for pupils, and in this area educational objectives are at least equally important as scientific ones. Citizen science activities appear to become more and more important in scientific education in schools as a form of project-based learning. Taking this into account, in chapter 5 this report presents an overview of educational citizen science activities that complements the literature review on citizen science activities in education.

Structure of this report

Chapter 2 of this report presents the methodologies for this report. Altogether, the research for Deliverable D1.2 consisted of literature analysis, web searches, and expert interviews. Chapter 3 presents analyses of citizen science landscapes in selected geographic areas. These analyses are based on a structured web information retrieval that is described in the methodology chapter. For some geographic areas either no information on citizen science in these areas could be found or there is no command of the official languages of these areas in the consortium. Consequently, the authors conducted interviews with experts on Open Science and citizen science in these geographic areas. Based on expert interviews, chapter 4 of this report discusses policy contexts of citizen science activities and issues of research ethics and research integrity of such activities. Chapter 5 gives the overview on citizen science-related educational activities in schools in Europe. Chapter 6 and 7 describe methodologies for Work Package 2, 3 and 4. Chapter 6 presents the binding force of the research methodologies in Work Package 2, 3 and 4: how they are related to each other, what methodologies are applied in these work packages, and, finally, how these methodologies have been revised when conducting the project. Chapter 8 of Deliverable D1.1 presented the role and context of computational analytics in CS Track and the methods to be applied for the analytics techniques to be performed in Work Package 3. Complementary to this description, Deliverable 3.1 presented the processing techniques Work Package 3 draws on and the different levels of analysis. In chapter 7 of this report these levels are further exemplified, furthermore, computational representations, methods of analytics and the operationalisation of indicators are described: the conceptual model underlying the structure of the database from which data are retrieved for web analytics in Work Package 3, attribution, the extraction of data, and the operationalisation of indicators.

The report closes with notes on contributions (chapter 8), a bibliography (chapter 9) and an annex with the interview guidelines and handouts for the expert interviews.

2 Methodology

Kathy Kikis-Papadakis, Michael Strähle & Christine Urban[2]

Several methods underlie this report. Capitalising on the language skills of the consortium - Arabic, Chinese, English, Flemish, French, German, Greek, Hebrew, Italian, Portuguese and Spanish -, **chapter 3**, the chapter on citizen science in selected geographic areas, was compiled by performing web searches in languages the consortium has competences in and conducting expert interviews. The web searches followed a common approach. Researchers looked for funding programmes on citizen science, publicly available policy papers, platforms and databases on citizen science, and citizen science associations, starting with websites of public authorities and research funders. When only very few or even no information resources could be found, this was verified by contacting public authorities to confirm it, and the researchers looked also for policy papers on Open Science to check if citizen science or citizen engagement is mentioned there. The language skills in the consortium allowed for covering Africa, the Americas, large parts of Asia, Europe, and Oceania. To cover as many European countries as possible, also those for which there is no language competence in the consortium or where there is a lack of literature and online resources, it was decided to conduct expert interviews to shed some light on the state of affairs of the Open Science and citizen science in these countries. In most cases researchers asked ministries of science to answer a few questions or to recommend experts on Open Science or citizen science to inform about the citizen science or Open Science landscape in the respective country. Altogether, 55 experts have been approached. Since citizen science is a part of Open Science and it was not assumed that every European country has a specific citizen science policy, the expert interviews focused on Open Science in general and citizen science. They were conducted in English and followed a common guideline according to which experts were asked about

- → the situation in respect to Open Science,
- → the areas and aspects of Open Science a government focuses on,
- → who promotes Open Science,
- → activities to engage citizens in science, how they are called and promoted,
- → citizen science associations, citizen science platforms and other information services on citizen science,
- → policy papers on Open Science and citizen science,
- → funding of citizen science,
- → debates on public engagement in science and science policy,
- → what these experts think about Open Science and citizen science in general.

(You can find the interview guideline, compiled by Christine Urban and Michael Strähle (Wissenschaftsladen Wien - Science Shop Vienna), in the annex to this report.)

[2] Authors listed in alphabetical order.

The interviews were conducted by email with experts answering the questions in the interview guideline they received. Because the interviews are expert opinions no interpretative analysis was performed. All experts received the guidelines before the interview as well as further details about the interview implementation (duration, summary length, consent forms, etc.).

The literature reviews that are presented in Deliverable D1.1 showed considerable gaps in our knowledge about citizen science, such as who participates in citizen science activities and what are their credible and proven benefits for volunteering citizens. To narrow some of these gaps, researchers conducted additional expert interviews with experts from China, Europe, Japan, South Africa, and the USA. These interviews are presented in **chapter 4**.

The interviews focused on two topics: Open Science on the one hand, research ethics and research integrity on the other. Therefore, the interviewers interviewed experts on research ethics and research integrity on the one hand, and experts on Open Science on the other. To avoid redundancies with scientific literature already analysed for Deliverable D1.1, the interviewers decided to select experts for the interviews that are less known in the field of citizen science, although it can be expected that they can contribute valuable insights into citizen science or citizen science-related practices: from a theoretical perspective and field experience. Since citizen science is such a broad concept, it was decided that experience and expertise in activities such as participatory environmental monitoring in sub-Saharan Africa, which are not called citizen science by those who organise and perform them, would qualify as experience and expertise in citizen science. Such activities in the global south often resemble citizen science in the global north. When pastoralists report changes in flora and fauna they often contribute traditional knowledge that goes beyond reporting data. They have to be considered as collaborators in scientific activities, not "only" contributors. To learn about pitfalls and good practice in such activities, the interviewers were also looking for experts with expertise in them.

As this research was exploratory, the interviewers also aimed at diverse perspectives and expertises among experts. When selecting experts, the interviewers considered several dimensions: geography, professional status and background, a sufficient visibility in the field, no close affiliation to those who are often cited in research on citizen science, and scientific expertise in respect to the topic of the interview, and gender. For finding experts, the interviewers looked up expert and working groups on the topics. When performing the literature reviews for Deliverable D1.1, the interviewers have found scientific literature that discusses issues pertaining to citizen science under perspectives that differ from the "mainstream" in citizen science. This made the authors of these scientific publications appropriate candidates for expert interviews. Even a superficial look at the citizen science landscapes and the discourses on citizen sciences shows that citizen science is most prominent in the UK, the USA, Germany, the Netherlands, Belgium, Switzerland, Austria, and Spain (especially Barcelona). To reduce geographic biases and the cumulative effects that come with them, the interviewers reached out beyond these geographic areas and approached experts from quite different geographic regions such as East Asia, the Americas, Australia, India, Southern Africa, and different European regions, including EU15 Member States. The covered professional roles of those experts include functions at research integrity offices, conducting academic research, giving policy advice, working as a librarian or research evaluator, having a management function at a university, a national science fund and/or advocacy group such as Science Europe and the European University Association, or working for an international organization such as the OECD and the United Nations. Their academic background covers the history and

philosophy of science, bioethics, political science, sociology, health research, social and cultural anthropology, biology, computer, environmental sciences, economic and communication sciences, and physics.

Citizen science, understood as the involvement of citizens in scientific processes, is one of the eight ambitions of the EU's Open Science policy[3]. The other ambitions are Open Data, the European Open Science Cloud, new indicators for research quality and impact, mutual learning about rewards for researchers to engage in Open Science activities and about alternative metrics to measure impact and quality of research, open access to scholarly communication, rewards, incentives, and recognition for practicing open science, research integrity and reproducibility of research results, and training for researchers in Open Science. To put citizen science in such a broader context instead of focusing on citizen science alone, the interviewers asked about

- Open Science policies and programmes,
- positive and negative experiences with areas of Open Science,
- focus shifts between these areas and why they happened,
- promising and unpromising areas of Open Science,
- understandings of citizen science,
- pros and cons of citizen science, and
- positive and negative experiences with citizen science.

(You can find the interview guideline, compiled by Christine Urban and Michael Strähle (Wissenschaftsladen Wien - Science Shop Vienna), in the annex to this report.)

To learn more about ethical issues, potential pitfalls and caveats in citizen science, interviewers asked about ethical issues experts see in citizen science and how these issues can be mitigated or even solved.

All interviews for chapter 4 were conducted in English and face-to-face via video connections or by email with experts answering the questions in the interview guideline they received. As for the expert interviews for chapter 3, no interpretative analysis was performed because the interviews are expert opinions.

CS projects/platforms/activities in European countries were sought through direct contacts with European Ministries of Education; nine of which provided us with the requested information. That information is highlighted in chapter 5 (Table x). Subsequently, the research on citizen science (CS) on education focused mainly on the repository of the community for Science Education in Europe (www.scientix.eu/, Scientix) that includes co-funded European Project for STEM in education. For getting more scientific results in this topic there was an extensive bibliographic search via google search engine and databases such as Google Scholar and Scopus. The search term 'Citizen Science in Education' was used. Noted should be that while there are numerous publications referring to CS programs / projects, the related literature pertaining to educational factors (pedagogies, trajectories, effects, etc.), but especially on the integrations of CS concepts on to the curricular structures across countries and educational systems are rather limited. To avoid reporting only numbers of observations in the identified programs / projects, it deemed necessary to set criteria. As such, the search terms used were: 'results of CS in secondary education' or

[3] https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/open-science_en

'primary education', 'impact of CS in secondary education', 'development skills of CS project in education'.

Under these criteria setting, the search identified 50 articles. The project's (CS-Track) research questions further guided the selection in terms of relevance which of course resulted in a more limited number of relevant articles representing the activity context of programs / projects implemented in the school sector. The initial review of all 50 summaries led to a smaller number of articles. These articles were thoroughly checked to ensure that they met the inclusion criteria. Additionally, references to selected articles were scanned to identify other articles that could be relevant.

After conducting the literature review and deciding on a final sample of 20 articles, consideration was given to how the articles will be used to conduct the appropriate analysis. Descriptive information, such as authors, years of publication, topic, or type of study, or in the form of effects and findings was not intentionally considered in the analysis. The selection criteria revealed several school sector cases, these are mentioned here below.

Title	**Link**	**Geographical region**	**Educational level**
Biodiversity at the Cemetery (BaF - Biodiversität am Friedhof	https://palaeontologie.univie.ac.at/en/research/palaeobotany-and-terrestrial-palaeoecology/projects/baf-biodiversitaet-am-friedhof/	Austria	Not specified
Bury tea bags for the climate (Begraaf theezakjes voor het klimaat)	https://www.iedereenwetenschapper.be/projects/begraaf-theezakjes-voor-het-klimaat	Netherlands	Primary, secondary
CAPTAIN: Science is the Captain	https://mes.gov.ge/content.php?id=10310&lang=eng	Georgia	Primary, secondary
Citizen Science Competence Centre	https://kodanikuteadus.wordpress.com	Estonia	Primary
CleanAir@School	https://www.eea.europa.eu/themes/air/urban-air-quality/cleanair-at-school	Europe wide: Estonia, Ireland, Italy, Malta, Netherlands, Slovakia, Spain, Scotland)	Primary, secondary
EDU-ARCTIC	https://edu-arctic.eu	Europe wide: Northern Europe (Norway, Iceland and the Faroe Islands), Western	Secondary

		Europe (France), and Central Europe (Poland)	
Healthy air, Healthier children	https://www.env-health.org	Europe wide (Germany, UK, Spain, France, Bulgaria, Poland)	Primary
miniMET	http://eu.minimet.net	Spain	Secondary
Plastic Pirates - Go Europe!	https://www.plastic-pirates.eu/de	Germany	Secondary
The Autumn Experiment	https://eu-citizen.science/project/35	Sweden	Primary
The Autumn Experiment (Höstförsöket)	https://forskarfredag.se/forskarfredags-massexperiment/hostforsoket-2013/	Netherlands	Not specified
The Risk Picture	https://eu-citizen.science/project/34	Sweden	Primary
X-Polli:nation	https://eu-citizen.science/project/74	United Kingdom, Italy	Primary
Measure for cleaner air (Meet mee voor een schonere lucht)	https://www.iedereenwetenschapper.be/projects/meet-mee-voor-een-schonere-lucht	Netherlands	Not specified
Fish Detective (Fischdetektiv)	https://www.buergerschaffenwissen.de/projekt/fischdetektive	Germany	Not specified
Live spring (Spring Alive)	https://www.schweiz-forscht.ch/de/tiere/item/262-spring-alive	Switzerland	Primary and secondary
Croatian Makers League	https://croatianmakers.hr/en/home/	Croatia	Primary and secondary
Awareness, education and action for invasive alien species in the forest	https://www.invazivke.si	Slovenia	Not specified
TSU – Children's University	http://junior.tsu.edu.ge/en/plwhlof1eeawv5snz/	Georgia	Not specified
ARCS	https://medborgarforskning.se/eng/	Sweden	Not specified

These cases could constitute the base for further analytical investigation in the research activities of the project's subsequent research tasks.

In Chapter 5 below, only a sample of these programs/projects are presented /outlined. The challenge for the research activities in CS-Track is to first identify other similar in scope programs/projects or adopt the ones identified here above to enhance understanding on the integration of CS concepts onto the school sector's curricular approaches and structures.

Drawing understandings on CS practices in countries not adequately represented in the literature reviewed

To fill the gap on the orientation towards CS in national contexts not adequately represented in the review of literature a dedicated task was put in place aiming at drawing information on the conceptual and practical orientation towards CS in such contexts. To this effect the project, through direct consultations with the National Ministries of Education/Higher Education and or Research, identified individuals within the countries which from the point of view of the Ministries qualified as national experts in the field.

A set of twenty-one countries formed our set of unrepresented countries in the literature (Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Georgia, Hungary, Latvia, Lithuania, Moldova, Montenegro, North Macedonia, Poland, Romania, Russia, Serbia, Slovenia, Slovakia, and Ukraine); twelve of which are present in our research. Our contacts resulted in the identification of sixty-six OS/CS experts all of which were invited to participate in a structured interview. Out of these thirty-four did not reply back, eight self-proclaimed as non-experts, six were positive but they did not have time for an interview, one was interviewed but never signed the consent form (the interview is not included in the current report) and 17 experts were finally interviewed. Nine experts chose to conduct the interview via email answering the interview questions while the other eight experts chose to have an interview via zoom. The interviews conducted via zoom lasted from 50 minutes to 1 hour and 15 minutes.

After the interviews, all the interviewees signed two different forms provided by the interviewer.

a. The Declaration of Consent data processing (DoC) which is a form about the collection and processing of personal data, required by the General Data Protection Regulation and

b. The Confirmation of summary which included a summary of each expert's interview (summary length between 200 and 1000 words).

These two documents are included in Annex x at the end of this document.

The information on CS that emerge for the national contexts of Albania, Bulgaria, Hungary, Latvia, North Macedonia, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, and Ukraine, via the expert interviews is presented in the following chapter.

3 Citizen science in selected geographic areas

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3.1 About the research

In 2020 an extensive **desktop research** on citizen science activities was performed. This research focussed on four types of sources:

- Policy papers on citizen science
- Platforms and portals on citizen science, which would list different citizen science projects
- Funding schemes for citizen science
- Citizen science associations, respectively networks

These four types of sources would tell much about how citizen science was framed and conceptualized in the European Union and internationally. If no platforms or portals listing projects were available in a country, some partners approached Ministries of Science or listed the individual projects they found. Desktop research was limited by language competences in the consortium. Expert interviews were conducted on countries for which no information was found in a language available in the consortium.

The country research for WP1 strongly synergized with WP2, especially with compiling a project database.

This desktop research was complemented with geographic expert interviews in several countries where no desktop research was possible due to language restrictions.

Table 1: Country or area by language command for desktop research, desktop research plan and geographic expert interviews

Country/Area	Desktop research possible?	Desktop research by	Geographic expert Interview by	Area or continent
Austria	yes	WLW		Europe
Belgium	yes	WiD, WLW		Europe
Bulgaria	not possible		FORTH	Europe
Croatia	not possible	WLW		Europe
Cyprus	yes	FORTH		Europe
Czech Republic	partially	ATiT		Europe
Denmark	yes	WLW, WiD		Europe
Estonia	not possible			Europe

[4] Authors listed in alphabetical order. Author is who contributed to writing this chapter and/or did research work for it.

Finland	yes	JYU		Europe
France	yes	WiD		Europe
Germany	yes	WiD		Europe
Greece	yes	FORTH		Europe
Hungary	not possible		FORTH	Europe
Ireland	yes	WLW, WiD		Europe
Italy	yes	WLW		Europe
Latvia	not possible		WiD	Europe
Lithuania	not possible			Europe
Luxembourg	yes	WiD		Europe
Malta	yes	WLW		Europe
Netherlands	partially	WLW, WiD		Europe
Poland	not possible		FORTH	Europe
Portugal	yes	UPF, WiD		Europe
Romania	partially	WLW	FORTH	Europe
Slovakia	partially	WLW	FORTH	Europe
Slovenia	yes	WLW	FORTH	Europe
Spain	yes	UPF		Europe
Sweden	yes	WLW		Europe
Albania	not possible		FORTH	Europe
Armenia	not possible			Europe
Bosnia and Herzegovina	not possible			Europe
Faroe Islands	yes	WLW		Europe
Georgia	not possible			Europe
Iceland	yes	WLW		Europe
Israel	yes	MOFET		North Africa & Middle East
Moldova	not possible			Europe
Montenegro	not possible			Europe
North Macedonia	not possible		FORTH	Europe
Norway	yes	WLW		Europe
Serbia	yes	WLW	FORTH	Europe
Switzerland	yes	WiD, WLW		Europe
Tunisia	yes	MOFET		North Africa & Middle East
Turkey	partially	FORTH, WiD		Eurasia
Ukraine	not possible		FORTH	Europe
United Kingdom	yes	WLW		Europe
South Africa	yes	WLW		Africa
Kenya	yes	WLW		Africa
Tanzania	yes	WLW		Africa
Seychelles	yes	WLW		Africa
Canada	yes	WLW		Anglo-America
USA	yes	WLW		Anglo-America

Brazil	partially	UPF, WLW		Latin America
Argentina	partially	UPF		Latin America
Chile	yes	UPF		Latin America
Colombia	yes	UPF		Latin America
Mexico	yes	UPF		Latin America
Peru	yes	UPF		Latin America
Ecuador	yes	UPF		Latin America
Costa Rica	yes	UPF		Latin America
Bahrain	yes	MOFET		North Africa & Middle East
Middle East	yes	MOFET		North Africa & Middle East
China	yes	WLW		Asia
Taiwan	yes	WLW		Asia
Singapore	partially	WLW		Asia
Japan	partially	WLW		Asia
South Korea	partially	WLW		Asia
Australia	yes	WLW		Australia
New Zealand	yes	WLW		Australia
Monaco	yes	WiD		Europe
Russia	not possible		WiD	Eurasia
San Marino	yes	WLW		Europe
Africa (transnational)	partially	WLW		Africa
Asia (transnational)	yes	WLW		Asia
Cayman Islands	yes	WLW		Anglo-America
European Union	yes	WLW		Europe
Hongkong	yes	WLW		Asia
India	yes	WLW		Asia
Latin America	yes	UPF, WLW		Latin America
Panama	yes	WLW		Latin America
EU multinational	yes	WiD		Europe
Jordan	yes	MOFET		North Africa & Middle East
global (transnational)	yes	UPF, WLW		global

Colour code:
- Member State
- Associated Country to H2020
- Other countries

Contributor codes

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[5] Listed in alphabetical order.

3.1.1 Overview desktop research findings

Table 2: Country or area findings by partner

Country/Area	FORTH	JYU	MOFET	RIAS	UPF	WiD	WLW
Africa (transnational)							X
Argentina					X		X
Asia (transnational)							X
Australia							X
Austria				X		X	X
Bahrain			X				
Belgium						X	X
Brazil					X		X
Canada							X
Cayman Islands							X
Chile					X		X
Colombia					X		X
Costa Rica					X		
Cyprus	X						
Denmark							X
Ecuador					X		X
Estonia						X	
EU multinational					X	X	
European Union					X		X
Finland		X					
France						X	X
Germany				X		X	
global (transnational)					X		X
Greece	X						
Hongkong							X
India							X
Ireland							X
Israel			X				
Italy							X
Japan							X
Jordan			X				
Latin America							X
Latvia						X	
Luxembourg						X	
Malta							X
Mexico					X		X
Netherlands							X
New Zealand							X
Panama							X
Peru					X		

Portugal					X		X
Singapore							X
South Africa							X
Spain					X		X
Sweden							X
Switzerland							X
Taiwan							X
Turkey						X	
United Kingdom							X
USA				X		X	X

Table 3: Country or area by type of finding

Country/Area	Platform	Policy paper	Funding	Other	Total
Africa (transnational)			1	1	**2**
Argentina	3		1	5	**9**
Asia (transnational)	1		1		**2**
Australia	1		5		**6**
Austria	2	5	4	4	**15**
Bahrain				1	**1**
Belgium	1	1		4	**6**
Brazil	1			2	**3**
Canada	2				**2**
Cayman Islands				1	**1**
Chile	1			1	**2**
Colombia	1			5	**6**
Costa Rica				1	**1**
Cyprus				4	**4**
Denmark	1			1	**2**
Ecuador	2			2	**4**
Estonia	1			4	**5**
EU multinational	1	1	1	3	**6**
European Union	3	25	9		**37**
Finland	6			3	**9**
France	4		1	5	**10**
Germany	2		1	52	**55**
global (transnational)	9		10	14	**33**
Greece	1		1	9	**11**
Hongkong				1	**1**
India				1	**1**
Ireland	2				**2**
Israel	1	1		6	**8**
Italy	1			2	**3**
Japan				1	**1**
Jordan				1	**1**
Latin America	1				**1**

Latvia				1	**1**
Luxembourg				2	**2**
Malta				1	**1**
Mexico	2			2	**4**
Netherlands		1		1	**2**
New Zealand	1		1		**2**
Panama	1				**1**
Peru	1			1	**2**
Portugal	3			2	**5**
Singapore	1				**1**
South Africa	1			1	**2**
Spain	3		2	10	**15**
Sweden	1			1	**2**
Switzerland	1		1	3	**5**
Taiwan	3	1	1	1	**6**
Turkey				4	**4**
United Kingdom	10		3	8	**21**
USA	9		6	6	**21**
Total	**85**	**34**	**49**	**178**	**346**

The number of findings in the different geographical areas varied strongly, which is not surprising. It must be considered that there is much over-regional, transnational or international cooperation in respect to citizen science. Hence, if a researched country did not yield any or only a small number of results, one cannot conclude that no citizen science happens there. It is more probable to assume that those who are interested in citizen science use opportunities that are not specific to their country.

Table 4: Findings in countries/areas according to their status relating to the Horizon 2020 Framework Programme for Research

H2020 status	Platform	Policy paper	Funding	Other	Total
Member States	28	7	9	106	**150**
Associated countries	12		4	21	**37**
EU (transnational)	1	1	1	3	**6**
Third countries	35	26	25	34	**120**
global	9		10	14	**33**
Total	**85**	**34**	**49**	**178**	**346**

Table 5: Finding overview by (sub-)continents and/or areas:

Continent/Area	Platform	Policy paper	Funding	Other	Total
Europe	43	33	23	120	**219**
Eurasian Countries				4	**4**
Africa*	1		1	2	**4**
Asia*	5	1	2	4	**12**
North Africa & Middle East	1			8	**9**
Australia	2		6		**8**
Anglo-America	11		6	7	**24**
Latin America	13		1	19	**33**
Global sites	9		10	14	**33**
Total	**85**	**34**	**49**	**178**	**346**

* Without North Africa & Middle East

Anglo-America: Region in the America in which English is the dominant language
Eurasian countries: Russia & Turkey
Latin America: Region in the America in which Portuguese or Spanish is the dominant language
Middle East: The Arabian Peninsula, Egypt, Iran, Iraq, and the Levant (except Israel)

Table 6: Ownership of websites and other sources

Who owns the source?	Platform	Policy paper	Funding	Other	Total
Nonprofit organisation	11	1	9	59	**80**
not obvious or mixed	33	1	5	35	**74**
Government	13	19	21	12	**65**
Public	9	1	5	17	**32**
University	3			22	**25**
Association	3	1		7	**11**
Enterprise	2			6	**8**
European Association		8			**8**
Foundation	3		2	3	**8**
intergovernmental	1		1	6	**8**
Nonprofit enterprise				7	**7**
Project (consortium)	3	1	1	1	**6**
European Commission		2	3		**5**
PPP	2		1	2	**5**
Individual Person	2		1	1	**4**
Total	**85**	**34**	**49**	**178**	**346**

Firstly, it was also attempted to find out which entities own websites or publish other information and thus can be interpreted as drivers of citizen science. Notably, it is not always easy to determine this ownership as there are partnerships across all kinds of entities. In many cases, extensive research would be necessary to find out who is behind a source of information. Also, the high number of non-profit-organisations has to be judged with caution, because the term NPO has many meanings. It can refer to grassroot initiatives and to organisations affiliated to public bodies, private companies, religions, governments or other kinds of organisations. Hence, this has to be regarded

as preliminary research that would require further investigations to find out which stakeholders are engaged and determine conceptualizations of citizen science.

3.1.2 Overview on geographic expert interviews

To provide a better overview on the experts' responses, they were divided into two main pillars: A. Open Science (OS) and B. Citizen Science (CS) in their countries. Below there are the main points of the experts' interviews under the name of their country presented in alphabetical order. The first section refers to OS and the second one to CS accordingly.

Table 7: Interviewed geographical CS experts in unrepresented countries. ¶

Participating countries¶	**Experts in OS and CS¶**
Albania	Blerjana Bino
Bulgaria	Peter Stanchev Kostadin Kostadinov
Hungary	Gyongyi Karacsony
Latvia	Gunta Kalvāne
North Macedonia	Aleksandar Karadimce
Poland	Agata Goździk
Romania	Cornelia Melcu Mihaela Cucu Alina Irimia
Russia	Alexandra Borissova
Serbia	Biljana Kosanovic Tanja Adnađević
Slovakia	Silvia Horakova Zuzana Stozicka
Slovenia	Jurij Krpan
Ukraine	Dmytro Khutkyy

3.2 About some exemplary geographic regions & countries

Albania

Source of information: Expert interview with Blerjana Bino

A Comments on Open Science in Albania

Open Science is a new concept in Albania not well understood by most of the people in the country. Moreover, OS has barely managed to penetrate in the Albanian higher education and the scientific community.

At a policy level, there aren't any initiatives regarding the opportunities and challenges presented by the OS. The new strategy about the scientific research (NSSTI 2017-2022) envisages only a contact person within the NASRI to serve as the liaison between the European Commission and the Albanian stakeholders on issues related to OS. The vision and objectives of this strategy do not integrate the underlying

principles of OS. Similarly, policies on research, science, innovation, and higher education need also to deal with the emerging trends of OS in Albania. Hence, there is a clear need for political commitment to promote OS and integrate it into the government agendas, as well as implement policies and allocate resources.

Only a few Higher Education institutions (HEIs) work towards OS and mostly in open access publications. The new legislation on Open Data is recently established in Albania but it is a fast-growing initiative that promotes transparency through the data publication regarding socio-economic indicators and public spending in Albania. Changes that are necessary for the universities and the research centres to integrate OS principles are not yet established in Albanian HEIs. One positive achievement so far is the online pre-print publication of all PhD theses in all HEIs.

The National Agency for Research and Innovation is possibly responsible for OS in Albania, but it does not do much. On the other hand, the Center Science and Innovation for Development makes efforts to attract universities' and donors' attention towards OS and CS in Albania. A seminar about science communication was organised in 2018 with the support of PERFORM and a report on science communication in Albania was published also including the OS aspect.

To highly benefit from OS and to be prepared for its full potential, research infrastructures and other technological advancements – data management systems – need to be further developed in HEIs. In addition, Albanian universities, research centres and other stakeholders in the science section need to plan strategically and develop policies to respond to OS. In addition, a legal framework of data usage and disclosure needs to be developed as well as financial mechanisms to support OS. Most importantly, Albanian stakeholders need to address these institutional challenges and prepare their structures and staff for OS.

B On Citizen Science in Albania

CS, as OS, is not an area of priority in Albania. There is no special funding for CS activities in Albania and only researchers working with EU or other donor funded projects have sensitivity towards OS and CS. The most popular OS and CS scientific topics in Albania are Information Technology, Agriculture, Tourism Development, Innovation, Entrepreneurship, Digitalisation, Cultural Heritage and Sustainable Development.

CS is not promoted in Albania and only during the COVID-19 pandemic some institutions such as the National Museum tried to offer online CS events or open days, but this initiative was very limited.

Useful resources:

Bino, B., (2018) 'Presentation of the study results – Understanding the current practices of science communication in Albania and Serbia – recommendations for enhancing effectiveness,
http://www.perform.network/upload/resources/documents/1CTb8Rh0.pdf

Study on Science Communication, https://wbc-rti.info/object/document/16842/attach/2017_Final_Report__Science_Communication_AL_SR.pdf

Austria

Source of information: Desktop research

Like in all countries belonging to the German language area, Austria has a platform on Citizen Science: "Österreich forscht" (Austria does research). It started in 2014 and has a project database allowing for keyword research. Responsible for the content is a working group situated at the Universität für Bodenkultur (University of Natural Resources and Life Sciences).

In 2017 the Netzwerk für Citizen Science (Network for citizen science) was found with a number of public organisations, non-profit and research organisations.

Citizen science is a topic of science policy since 2015 at least. In this year it was mentioned in the Federal Ministry of Science, Research and Economy's Aktionsplan für einen wettbewerbsfähigen Forschungsraum (Competitive Research Area Plan) as a model of participatory research (Bundesministerium für Wissenschaft, Forschung und Wirtschaft, 2015). The Zentrum für Citizen Science (Center for Citizen Science) of OeAD (the Austrian Agency for Education and Internationalisation) was established in June 2015 as a knowledge and networking hub. Funded by the Federal Ministry of Education, Science and Research, the Center coordinates a network of citizen science contact persons at Austrian research institutions and a working group on "Citizen Science in/with schools". It also manages two projects/funding lines that are mainly geared towards schools - Sparkling Science 2.0 and the Citizen Science Award. The Austrian Research and Technology Report 2017 provided a short overview of citizen science initiatives in the Austrian research area (Bundesministerium für Wissenschaft, Forschung und Wirtschaft & Bundesministerium für Transport, Innovation und Technologie, 2017).

The Austrian Science Fund offers grants for citizen science projects through its Top Citizen Science (TCS) Funding Initiative. This funding programme was launched in 2016 and has a budget of 250,000 € per call (i.e. per year). Eligible are projects with non-profit organisations. The Innovationsstiftung Bildung funded the development of e-learning content by explicitly following a citizen science approach.

Further citizen science resources can be found, among others at the website of the University of Vienna, the University of Innsbruck and the Museum of Natural History in Vienna, who are engaging in citizen science.

Belgium

Source of information: Desktop research

In 2016 the Royal Belgian Institute of Natural Sciences (IRSNB) published a strategy paper which cited 'involving citizens in the process of research', i.e. strengthening the Institute's ties with learned societies and citizen science ('sciences participatives') in general, as one of 17 goals. The current strategy paper, by contrast, does not mention citizen science at all. Nevertheless, the IRSNB Museum is one of the project partners of EU-Citizen.Science and has been involved in several CS initiatives (including a BioBlitz event, the XperiBIRD.be bird monitoring project for primary and secondary schools, and the EU-funded project DITOs - Doing It Together Science).

In 2017 the Department of Economy, Science & Innovation of the Flemish government launched a dedicated grant programme for citizen science projects. So far, 20 projects have been funded with a total of 2,900,000 €. They are listed on the online

platform Scivil (Citizen Science Vlaanderen), which is managed by the Roger Van Overstraeten Society and likewise (partially) financed by the Flemish government. Scivil also offers CS-related news and event notices, success stories, as well as guides and manuals.

Scivil platform: *https://www.scivil.be/about-scivil*

A second web platform, called Iedereen Wetenschapper, collects CS projects from different scientific fields. It was created in 2015 by Eos Science (a popular scientific magazine and publishing house), supported by the Young Academy Flanders and Scientific American. It is affiliated with the international Citizen Science Association and with the European Citizen Science Association (ECSA). In addition to the CS project directory, Iedereen Wetenschapper operates a monthly newsletter, social media channels and a blog. It currently lists 425 active CS projects.

For the Wallonian part of the country, the nature conservation association Natagora occasionally organizes biodiversity monitoring workshops and publishes CS-related news. Its Flemish counterpart Natuurpunt has a very similar profile.

In terms of data management and validation, the biodiversity database Observations.be (also known as Waarnemingen.be) is arguably the most important piece of Citizen Science infrastructure in Belgium. It is run by Observation International, a Dutch non-profit foundation, in cooperation with Natagora, Natuurpunt and other partners and allows registered users to submit observations directly on the website or via the smartphone app ObsIdentify.

Bulgaria

Source of information: Expert interviews with Peter Stanchev and Kostadin Kostadinov

A Comments on Open Science in Bulgaria

The Open Science concept is new in Bulgaria. The current Deputy Minister, Ms Karina Angelieva, who is responsible for Science in Bulgaria, is the first person that really wanted to promote OS in the country. The current situation in Bulgaria reveals that people are still afraid of doing something innovative regarding OS. Some researchers are still sceptical about the open data and to keep their work open to the public. On the other hand, the early career researchers are more willing to publish their work in open access journals.

There are seven open access repositories in Bulgaria and two of them are managed by Prof Stanchev and the Institute of Mathematics and Informatics (Bulgarian Academy of Sciences). One is about maths publications and it is part of the European Mathematics Library. About the rest repositories in Bulgaria, the limited information we got is that the New Bulgarian University has all its publications in a public repository and the Bulgarian Academy of Sciences has another repository that includes a list of papers (unfortunately only the publications titles).

Regarding the national policy and infrastructure, a national programme about Information and Communication Technology for Single Digital Market and Science Education and Security which has a special package about open data was created two years ago. The government gives money for the development, the strategy, and the establishment of OS in Bulgaria. There is also the National Centre for Information and Documentation which is a governmental structure that develops a Bulgarian portal for OS. The portal isn't just another repository, but it includes all the metadata

available to everyone. Another important field is training and support. In the frame of NI4OS programme, several workshops were organised to show how to work with these repositories. In the field of outreach and dissemination, there is an RDA programme with COVID-19 guidelines providing a portal with meetings and validation workshops.

The Ministry of Education and Science used to take care of all the scientific issues in Bulgaria. Now, some new agencies for science and innovation have been established that are responsible for science and all the relevant funding in the country. At the moment the government is trying to move some people from other Ministries to these new agencies.

In the field of the Task Force, Bulgaria participates in the European OS cloud. Twice a year, meetings are organised by the Ministry of Education and Science where the Deputy Minister and the President of Bulgarian Academy of Sciences discuss the national plan for innovation and OS in Bulgaria and the concept of the national programme for open access results and publications. At the end of September 2020, at the *Eleventh National Information Day: Open Science, Open Data, Open Access, Bulgarian Open Science Cloud*, it was presented how the Bulgarian Open Science cloud will be established and how it will be part of the European Open Science cloud with services, elements, and data. The day was hosted by Ms Karina Angelieva, the Deputy Minister of Education and Science and Mr Hristo Georgiev Secretary, the General Contact of the National Commission of the Republic of Bulgaria for UNESCO. Apart from these meetings, the Ministry of Education and Science organises a series of seminars, which are open to the researchers of the Bulgarian Academy of Sciences, to people holding key positions in the Ministry and other relevant stakeholders.

B On Citizen Science in Bulgaria

There are two main CS events in Bulgaria, the Researchers' Night, and the Science Festival. The Science Festival takes place on the 11th of May (Saint Cyril's day) in Sofia and many universities and research institutes participate. Science Festival is an open-air festival that is in every neighbourhood around Sofia. Moreover, the universities in Bulgaria organise open days, every year. Open days are events where citizens can visit the universities and learn about science and research that academics and researchers work on, in each university.

Muzeiko museum is a children's museum in Sofia. Muzeiko usually organises events for children such as the children's laboratory which always participates in the Science Festival in May. The events are free to everyone and only in the events that the places are confined, a pre-registration is needed. The Science Festival is supported by the Ministry of Education and Science. In Bulgaria there are no special calls or funding dedicated to CS projects and there is not a national regulation for science festivals in Bulgaria.

There are also some workshops that are organised in Bulgaria by the universities and the research institutes, but they are characterised more as scientists' initiatives. Some of the events and competitions are sponsored by computer companies.

Moreover, the European Researchers' Night event takes place in Bulgaria every year. School and undergraduate students participate in the Researchers' Night event in Sofia and in other cities within the country. Scientific groups in universities try to collaborate with the museums and participate in the European Researchers' Night event organising activities for the general public. Their aim is to keep the cultural heritage close to the scientific heritage in Bulgaria for all the citizens.

The events are advertised mainly through the national Bulgarian radio, social media accounts, national and international websites and through the Ministry of Education and Science.

The real impact of science is to approach ordinary people. Science is not only for scientists, but it is more than important to attract a general audience and make science and research results open to everybody. The next step to promote OS in universities and research institutions is to put regulations about the repositories and the open access publications.

Canada

Source of information: Desktop research

The Canadian government operates a citizen science portal that lists 43 projects (as of 22/12/2021) in which citizens can participate.[6] In this portal, the Canadian government asks researchers to report their citizen science projects so that they can be listed in the portal and thus made visible. The projects listed are mainly from the environmental sector and deal with nature conservation, biodiversity, agriculture, animal observation, weather observation, health, and other topics. These projects are supported by national parks, NGOs, universities, government agencies, museums and zoos and probably financed at least in part by their operators; a government funding programme for citizen science is not listed in the portal. The extent to which research projects take citizen science into account and are funded for it would have to be investigated based on the various government research funding programmes and any funding from private foundations. 43 projects may not sound like much, but it should be considered that in Canada, like in the USA, community-based research - which are presumed to be grassroots projects that address the concerns of communities with their participation - and service learning have a long tradition at universities. Such projects do not necessarily see themselves as citizen science, which is why they do not appear in relevant project databases under this keyword. Consequently, the citizen science landscape in Canada is probably more colourful and diverse than the portal suggests.

Denmark

Source of information: Desktop research

The Danish citizen science platform citizenscience.dk, which is managed by the Dansk Citizen Science Netværk, presents projects on various topics. The Netværk also organized a first Danish Citizen Science Symposium in 2019.

The University of Southern Denmark has established a Citizen Science Knowledge Center, which currently runs nine citizen science projects and offers advice and support to scientists interested in involving citizens in their research.

Aarhus University, an ECSA member, is also quite active in the field of citizen science. It is involved in a handful of citizen science projects, as well as in the EU-funded initiative TIME4CS, and will host a large citizen science conference in April 2022.

[6] https://science.gc.ca/eic/site/063.nsf/eng/h_97169.html

One example for a large and well-publicized citizen science project in Denmark is Biodiversity Now, which was able to collect more than 1 million observation records via the smartphone app Nature Check. The project was jointly managed by the Danish Society for Nature Conservation, the University of Copenhagen and Aarhus University, with financial support from the Aage. V. Jensen Nature Fund.

Finland

Source of information: Desktop research

In Finland there are several projects collaborating with lay researchers in the field of nature observation and biodiversity. Among those engaged in the field are for example the Natural Resources Institute Finland (LUKE) with their website *Riistahavainnot*[7], the Finnish museum of natural history with Luomus[8], the nature association Luonto-liitto with *Kevätseuranta*[9] or the Finnish biodiversity information facility with *Suomen Lajitietokeskus*[10]. International citizen science projects like BirdLife have Finnish branches, too. The Finnish branch of Birdlife maintains a nationwide birdwatching system called Tiira[11] to which birdwatchers can report sightings. Another driver for citizen science are environmental institutions like the Finnish Environment Institute SKYKE which entertains the *Järvi ja Meri Wiki*[12], and there is a joint website of Finnish environmental administration bodies titled Kansalaishavainnot[13]. Citizen science about other natural phenomena is not surprisingly present in Finland, too, with *Sääsovellus/Ilmatieteen laitos*[14] from the Finnish Meteorological Institute and Taivaanvahti[15] from the URSA Astronomical Association.

France

Source of information: Desktop research

In France, citizen science (science participative) has been relatively high on the political agenda for several years. In 2016, François Houllier, President of the National Institute of Agricultural Research and the National Research Alliance for the Environment, presented a report on citizen science in France, which had been commissioned by the Ministry of Education, Higher Education and Research and drew on interviews with 150 individuals and the responses of c. 600 internet users who participated in an online consultation. This report contains good practice guidelines

[7] https://riistahavainnot.fi/

[8] https://www.luomus.fi/fi/osallistu

[9] http://kevatseuranta.fi/

[10] https://laji.fi/

[11] https://www.tiira.fi/index.php

[12] http://www.jarviwiki.fi/wiki/Havaintol%C3%A4hetti

[13] www.ymparisto.fi/fi-FI/Kansalaishavainnot

[14] https://ilmatieteenlaitos.fi/omat-havainnot

[15] https://www.taivaanvahti.fi/

and policy recommendations geared towards promoting the dissemination and implementation of citizen science in France.

There are currently several different citizen science organisations and platforms, most of which are somehow affiliated with the National Museum of Natural History and Sorbonne University and focus on environmental protection and monitoring.

Tela Botanica, a network of French-speaking professional and amateur botanists, offers many opportunities for volunteers to contribute to botanical research.

J'agis pour la nature (I take action for nature), a volunteering platform managed by the Fondation Nicolas Hulot pour la Nature et l'Homme (a private non-profit organization) lists possibilities for citizens to take action for the protection of the environment (including crowdsourced biodiversity monitoring projects etc.).

The Sorbonne University Alliance is currently involved in 46 citizen science projects, which are listed on the website Science Ensemble (Science Together). Unlike most other French CS platforms, Science Ensemble covers many different research areas. It furthermore functions as a hub for the citizen science professional network and contains various resources (such as reports, online courses, journal articles, as well as CS-related news and event announcements).

As founder and head of the citizen science network Vigie-Nature, which was launched in 1989 and initially focused on bird monitoring, the National Museum of Natural History (co-)manages 21 biodiversity-related citizen science projects. Information on these 21 projects and on how to become involved, along with project results, training materials and CS news can be found on the Vigie-Nature website.

The most comprehensive French CS online platform is OPEN (Observatoires Participatifs des Espèces et de la Nature), which was developed by Sorbonne University and the National Museum of Natural History with funding from the Fondation de France (the country's largest network of philanthropic organizations) and the French Biodiversity Agency (a public body under the authority of the ministries of ecology and agriculture & food). It bundles information from several other CS initiatives or networks and currently lists around 150 active citizen science projects, which can be filtered according to several criteria. As the platform's name indicates, its focus is very clearly on environmental and biodiversity monitoring.

The two key players in the field of citizen science in France, the National Museum of Natural History and Sorbonne University, have recently co-founded a consulting agency called Mosaic (Méthodes et outils pour les sciences participatives / Methods and tools for citizen science).

Germany

Source of information: Desktop research

One of the main drivers of citizen science not only in Germany but also in the European context are Wissenschaft im Dialog and the Museum für Naturkunde Berlin. Their joint project is the elaborated citizen science platform *Bürger schaffen Wissen*, which is funded by the Federal Ministry of Education and Research and which provides a variety of resources relating to citizen science (including literature reviews, interviews with practitioners, guidelines and FAQs) and lists ongoing projects in Germany along with information on how to become involved. The platform also promotes networking among different citizen science initiatives by organizing regular conferences, hosting

several working groups, and offering workshops. Citizen science project coordinators can upload their projects and their outcomes on the platform, exchange their experiences and cross-link; interested citizens can also search for suitable projects by means of filters.

In 2017, *Bürger schaffen Wissen* presented its Citizen Science Strategy 2020 for Germany. This green paper outlines the aims, potential and challenges of Citizen Science in Germany and offers recommendations for developing a national strategy for engaging citizens in science. The White Paper *Citizen Science Strategy 2030* is currently being drafted and will be published in spring 2022.

Bürger schaffen Wissen also organises an annual citizen science conference - the Forum Citizen Science. With a varied programme comprising workshops, project presentations and panel discussions, this conference, which was first held in 2016, has become the leading networking and discussion platform for Germany's citizen science community. The platform was also a strong driver behind the establishment of ECSA, the European Citizen Science Association, which was situated at the Museum of Naturkunde Berlin for many years.

Several universities, research institutes, learned societies and NGOs also manage or support citizen science projects. Examples include the NABU (Nature And Biodiversity Conservation Union), the Leibniz-Gemeinschaft, the University of Münster, the Helmholtz-Gemeinschaft, Ulm University, the University of Potsdam, the TH Wildau, the Hochschule Bonn-Rhein-Sieg, the Gesellschaft für Archäologie in Württemberg und Hohenzollern e.V. (Archeological Society Wurttemberg and Hohenzollern), the Naturhistorische Gesellschaft Nürnberg (Nuremberg Society for Natural History) etc.

Funding for citizen science projects is mainly provided by the Federal Ministry of Education and Research (BMBF), which launched its first citizen science-specific funding programme in 2016. A second call for proposals was announced in October 2019 for the funding period 2020-2024. Currently, 15 citizen science projects are being funded by the BMBF with a total budget of around 9,000,000 €.

Hungary

Source of information: Interview with Gyongyi Karacsony

A Comments on Open Science in Hungary

During the last 1 or 2 years there has been great progress towards Open Science in Hungary. However, there have been initiatives promoting OS in the country since 2008. The very same year, the first repository at the University of Debrecen was created. Although nowadays most of the universities in Hungary have their own document repository, there are only two data repositories in the country; one is managed by the Research Institute of the Academy of Sciences and the other one by the University of Debrecen.

In 2008, the National Library of the University of Debrecen established a network called HUNOR. HUNOR is a group of librarians working in universities' libraries and in the Library of the Academy of Sciences. HUNOR promotes OS, open access and open education providing training and workshops dedicated to librarians, scientists and early career researchers organising activities with the latest news for OS, EC policies and workshops for data management plan and FAIR data. The National Research, Development, and Innovation Office (NRDI Office) of Hungary which acts under the Ministry of Innovation and Technology provides funding for these training programmes.

The main funding for OS events in Hungary is coming from Horizon 2020 and EC programmes in general. There are some occasional calls for OS from national funds, such as the one from NRDI Office presented above, for 20 training sessions in 12 months at the National Library of the University of Debrecen.

Lately, a new collaboration between the Hungarian Research Data Alliance Office (HRDA), the Library of the Academia of Sciences and the KIFU which is the main e-infrastructure and IT in Hungary was established. The representatives of these organisations should follow the same direction regarding the national policy level to make this collaboration fruitful and make it open for the scientific and the educational community. It is more than important for all the key participants and stakeholders to be ready and open to conversation, to succeed this complex change to implement good OS policies in Hungary.

B On Citizen Science in Hungary

Regarding the CS events in Hungary, there is the European Researchers' Night which is a very popular event and both universities and libraries have a major role in this event. Other festivals are the Museum's Night festival in June and the Night of Libraries. All the events are specially organised for the general public and attract different target groups of all ages. The biggest universities in the country have their own museums so there are standard collaborations between the scientists and the museums. There is also a very popular music festival taking place in Budapest every year and many libraries, such as the National Library of the University of Debrecen participate in this event.

Furthermore, every year universities organise Open Days which are addressed to the high school students. Within universities, there are programmes for elderly people as well as Science Cafes to engage the general public and bring them closer to the scientific topics.

Schools and universities have established active partnerships; schools visit the universities and scientists visit schools very often organising together many educational events. All the events are free for the general public and only some events that have a specific number of participants request a pre-registration.

Ireland

Source of information: Desktop research

The National Biodiversity Data Centre (NBDC), which is managed by the Irish government's Heritage Council and co-funded by the Heritage Council and the Department of Housing, Local Government and Heritage, operates several biodiversity monitoring programmes that rely heavily on the contribution of citizen scientists. Examples include the Irish Butterfly Atlas or the Marsh Fritillary Monitoring Scheme. Its homepage offers a downloadable beginners' guide, online courses on how to get started, and a list of active citizen science projects. Furthermore, the NBDC is an ECSA member and has developed a smartphone app for recording observations in the field.

Citizen Science Ireland is an initiative that aims to connect researchers with volunteers and create synergies, specifically in the STEM field. It is affiliated with the ECSA and receives funding from the European Commission, the European Regional Development Fund, and the Science Foundation Ireland. While Citizen Science Ireland

does not conduct its own citizen science projects, the website does list a few projects the initiative is involved in.

Several NGOs, including the Irish Wildlife Trust, BirdWatch Ireland, Bat Conservation Ireland etc., run citizen science projects related to environmental protection and biodiversity. The Environmental Protection Agency (an independent public body) supports many of these initiatives and provides a comprehensive list of ongoing citizen science projects on its website.

Other institutions active in the field of citizen science include the Irish Times, the Science Foundation Ireland, and Trinity College Dublin, which has collaborated with EU-Citizen.Science to create a community page for Ireland within the EU-Citizen.Science online forum.

Israel

Source of information: Desktop research

TCSS (Taking Citizen Science into School) centre is related to citizen science educational projects; implementation. The team of the TCSS centre, is composed of researchers who specialise in enhancing learning through technology and science – see the TCSS team here https://www.tcss.center/team-en.

TCSS focuses on citizen science projects. Citizen science projects aim at engaging the public, including volunteers from all around the world participating in activities such as monitoring of climate phenomena, water quality, bird distribution, historical document analysis, and the discovery of new planets and galaxies. The idea behind research and practice is that science is not only for virtuous individuals, but it is open to the general public.

Citizen science benefits both science and citizens. Citizens help scientists with data collection and/or analysis, which are a significant contribution, especially when it comes to the environmental research that requires the collection of large amounts of data with an extensive geographical distribution. Citizens are actively involved in research, contribute to science, learn new topics, and join a social circle of science practitioners. New technological developments, and in particular web and digital tools, improve the data collection performed by the public. Innovative mobile technologies, such as smartphones, tablets with sensors, have the advantage of allowing data collection and data entry in real time from different geographical regions.

For the school projects, teachers may download instructions and organised activities for their classroom. These projects deal with birds and butterflies counting (teachers are asked to join the national birds/butterflies counting), survey of the Radon Gaz (including units for classroom activities), involve young students in identifying accessible paths for blind people in their neighbourhoods, and transmitting their findings through GIS for the local policy makers (to improve the design of new paths for the blind people).

TCSS platform is coordinated by researchers who work on students and teachers' participation in various scientific activities. TCSS also supports the engagement of the young generation with science (similar to the approach taken by SwafS). On the other hand, the centre was established by the national science foundation and the Ministry of Education as part of the efforts of supporting "meaningful learning" in school.

In general, the Israeli Ministry of Education (MoE) hasn't established any policy related to citizen science, yet. The only organisations that promote CS policy in Israel are the society for the protection of nature (that also provide the resources to the national birds and butterfly counting), universities and research institutions (e.g the Technion and Haifa university) as well as museums, such as the natural history museum of Tel-Aviv. The main interest of these organisations is to raise public awareness (a special focus is given to schools and students) towards species extinction and environmental issues related to citizens' wellbeing. TCSS' website enhances teachers and students' participation in scientific research (and provides a database for citizen science activities in schools) and this is the first step of changing the Israeli citizen science future.

Latvia

Source of information: Expert interview with Gunta Kalvāne

A Comments on Open Science in Latvia

In Latvia, the Ministry of Education and Science is promoting Open Science with a focus on data sharing and science communication. The Ministry commissioned the Open Science Latvia landscape research study. Based on the report (published only in Latvian, but results have been presented at a conference in English by Jānis Kreicbergs) from this study, a national strategy for Open Science (including open data sharing; citizen science etc.) is currently being developed.

B On Citizen Science in Latvia

Citizen Science activities are not centrally organised in Latvia; Most are separate activities initiated by individual scientists or an NGO. There are no general regulations, rules and no long-term funding programmes. This leads to many short-term activities, except for nature data collection and monitoring projects, for example about phenology, bird migration or butterflies organised by the Latvian Nature Fund (NGO). In these areas, a strong network with many enthusiasts exists and biodiversity data is submitted to the data platform www.dabasdati.lv using an app. Citizen Science activities in meteorology also have a long tradition in Latvia with many people recording weather conditions in different locations and sharing their data with radio or TV stations (also now by sending in pictures as photo evidence). Another popular Citizen Science activity is digitizing old manuscripts organised by the National Library of Latvia. A new Citizen Science activity is writing diaries to collect memories of the experiences during the Covid-19 pandemic (http://garamantas.lv/en/collection/1415829/Pandemijas-dienasgramatas-2020).

Citizen Science activities generally aim to increase public knowledge about science and mainly involve people in certain aspects of the scientific process by observing, gathering and processing data (e.g., monitoring of butterflies, bird migrations, plant phenology). Activities that involve citizens in setting a scientific agenda and/or co-designing and implementing science-related policies are still work in progress. The activities are sometimes but not always called Citizen Science, broader terms such as popular science or science communication are used as well. Citizen Science is one of the Open Science areas that the Ministry of Education and Science is supporting. There is an Open data platform but no national or regional associations for Citizen Science. Funding for Citizen Science is project-specific, there is no general Citizen Science funding programme. Public engagement with scientific research and science

policy is becoming more popular. Webinars and discussions around this topic have been taking place in the last few years and some projects have been launched. So far there is no strategy in place though.

Personal statement on OS/CS: I'm working in the field of phenology and I`m using Citizen Science data all the time. I see the benefit of Citizen Science and believe that it is a future of science – Open data, sharing, everybody evolves in science – be a part of it. Last year we digitized historical phenological data by volunteers from 1970-2018 and now they are freely available to everybody on Zenodo (https://zenodo.org/record/3982086#.YBHLVegzblU). I think it is our moral duty and mission as scientists to share our knowledge, data and to communicate with society, explain different topics in all disciplines. The Covid-19 crisis enlightened us that we are not working hard enough, at least our society trusts influencers more than scientists. Also, it is a pity that some colleagues are not welcoming Citizen Science. But I hope that the new Open Science strategy will give Citizen Science a political and financial framework.

North Macedonia

Source of information: Expert interview with Aleksandar Karadimce

A Comments on Open Science in North Macedonia

OS is not highly promoted in the Republic of North Macedonia (RNM). Universities and scientific organisations have not organised or participated in OS events in the country. The Ministry of Education and Science (MES) is the main responsible for promoting all the science projects in RNM, but there are no serious actions to promote Open Science.

In 2015, the government organised an event for the promotion of scientific achievements in the country and the establishment of the science portal nauka.mk. This science portal hosted all the results of the scientific work presented in the event, in cooperation with the researchers from the higher education and the scientific institutions in RNM. All the results were open to the local and the international scientific community as well as to the general public. The UIST Ohrid built the science portal nauka.mk for free for the MES. All the activities organised on the portal stimulated the scientific discussions as one of the most important tools for evaluation of the scientific research activity, defence of the research results and promote the generation of new scientific ideas. The public and the private sectors, as well as the general public, were informed for these scientific achievements. Today this portal is not in use, and it is not publicly accessible. Also, the database remains offline.

B On Citizen Science in North Macedonia

CS initiatives are very rare and most of them are promoted by NGOs in North Macedonia. Using the latest technology trends, social media are used to promote CS events. The absence of CS articles, policy papers and funding schemes for universities, schools or other public or private organisations are the main reason why there are no CS initiatives in the country.

A popular CS event is the Mini Maker Faire which is a global movement of makers, inventors, creators, artists, scientists and technology enthusiasts to encourage science curiosity, promote the free flow of ideas and spread knowledge and experience in the community and around the world. The UIST Ohrid and the American Corner from

Struga participated in the launching of the first Maker Faire in Bitola, in 2018 (https://bitola.makerfaire.com/). In 2019 the Mini Maker Faire was supported by the Call for Makers in UIST Ohrid https://skopje.makerfaire.com/. Students from UIST Ohrid participated in both events.

Another CS initiative in North Macedonia is the "Наука за Сите" - English translation "Science for All", https://nzs.mk/. This CS initiative is brought up by the North Macedonian scientists and authors from all around the world. "Science for All" is enriched by 25 promising scientists who have written or are still writing popular scientific articles on the web page. Without their knowledge, enthusiasm and desire, the website of "Science for All" could not exist. In addition to the popularisation of science in the North Macedonian language, the "Science for All" additionally aims to connect and network scientists working in RNM and abroad. The OS initiative is very general promoting the natural scientific fields from Astronomy, Biology, Cognitive Science, Computer Science, Mathematics, Social Science and Technology in general, Physics and Chemistry.

The only initiative in the primary schools to promote STEM skills is the project "21st Century Schools" in primary schools in RNM. The British government invested 10 million pounds to help one million students from the Western Balkans to acquire digital skills (https://meta.mk/en/through-the-schools-of-the-21st-century-project-the-children-will-acquire-digital-skills/). The National Project 'The 21st Century Schools" was launched in December 2017 by the Western Balkan British Council, and it is locally supported by the MES of RNM. The children that have participated in the project activities have been invited by their teachers as part of their curricula.

The American Corner from Struga has established a free after-school coding club for young people, as part of the CoderDojo movement since May 2019. CoderDojo is a global, volunteer-led movement that organises free computer clubs for young people aged 7–17, and there are CoderDojo clubs in countries all over the world. The CS activities require mentors - adult volunteers, with or without technical skills, who provide support, guidance, and encouragement to young people to complete their projects and develop their skills. The CoderDojo meeting has been publicly promoted by the schools, universities, and social media.

Science education for adults and minors can be best promoted by hands-on activities. The mentor/trainer should have the role of an educator to support and guide the children in the process of learning the core skills. After this process the children should be left to express their creativity and only support children when making choices, team brainstorming, finding solutions and practising interpersonal and self-directed skills.

There is a great need for more CS activities to promote OS in RNM. Access to calls and funding opportunities, such as the National grants and the EU OS calls for CS initiatives are not available. Universities will be the best place to initiate OS because professors and students are willing to promote OS and CS in the country.

Netherlands

Source of information: Desktop research

In 2016 the Dutch Presidency of the European Council issued the policy paper *Amsterdam Call for Action on Open Science*, which contains numerous references to citizen science. One year later, the Dutch government launched a National

Programme Open Science (NPOS) that comprises a dedicated Citizen Science Programme Line. In November 2020 the NPOS Citizen Science Working Group published a report on the status of citizen science in the Netherlands.

At the moment the NPOS Citizen Science Programme Line is conducting an open consultation on the NPOS2030 Ambition Document, the Key Lines of Action for Citizen Science, as well as on their vision for Citizen Science in 2030. It is also working on establishing a Dutch Citizen Science Practitioners Network (the 'CS-NL Network'), whose official launch is planned for 2022.

In February 2021 ZonMw, an independent administrative body that manages funding programmes on behalf of the Dutch Ministry of Health, Welfare and Sport and the Dutch Research Council, started the funding line *Citizen Science for Health and Care* (total budget: 1 million €) which offers financial support to health-related CS projects for a duration of up to two years. In 2020 the Dutch Research Council itself introduced a budget module that allows applicants to request funding (up to 15,000 € per year) for citizen science activities carried out in the context of their research projects.

The Citizen Science Lab at Leiden University conducts its own citizen science projects in addition to contributing to the Horizon 2020 projects SciShops and EU-Citizen.Science.

When it comes to citizen science data management infrastructure, Observation.org is the largest player in the Netherlands. Developed by the Dutch non-profit foundation Observation International, it allows users to submit biodiversity monitoring data via the website or via a smartphone app. The data collected through Observation.org feeds into the GBIF (Global Biodiversity Information Infrastructure).

Norway

Source of information: Desktop research

In Norway, as is many other countries, citizen science initiatives mostly revolve around biology and nature conservation. The main piece of citizen science infrastructure in Norway is the *Rapportsystem for arter* (Species reporting system), a platform for citizen-collected data on biodiversity that collaborates with several botanical, zoological, ornithological and entomological societies and receives funding from the Ministry of Climate and Environment.

Sabima, an umbrella organization for Norway's various biology-related learned societies, also encourages nature enthusiasts to collect and submit biodiversity data. Sabima has developed a smartphone app entitled Artsjakten (Species Hunt) specifically for this purpose.

Poland

Source of information: Expert interview with Agata Goździk

A Comments on Open Science in Poland

OS in Poland mainly focuses on open data (publications in open access journals, datasets and scientific results open to the general public). Recently, the Ministry of Education was merged with the Ministry of Science under one common Ministry.

The Ministry of Science used to focus on open data policy and lately it tried to support and promote CS. Unfortunately, there aren't any dedicated calls, policy or funding for schools and CS activities in Poland. There was only one programme (finished in 2019) organised by the Ministry of Science, called "Dialogue", which was about science communication and dissemination of scientific results. On the other hand, the Ministry of Education supported Science Centres, such as the Copernicus Science Centre but it didn't support any CS individual initiatives.

B On Citizen Science in Poland

There are two main CS events in Poland. One is called Science picnic, which is a huge open-air festival organised by the universities and the research institutions in Poland and it attracts people interested in science. Its topics are quite general, and many different scientific disciplines are presented. The main event is in Warsaw but there are some other cities that host small events, too.

The second event is the Festival of Science that takes place in autumn. Warsaw University is the main organiser of the Festival of Science, but other institutions organise smaller events as well. It is also very popular, mainly organised in Warsaw and in other big cities in Poland. It looks like a festival, but it can be characterised more like an action. Although it is not as crowded as the Science picnic, people have the opportunity to visit real research laboratories and run experiments with the help of experienced scientists.

There are also some other smaller events in Poland, such as the events for children and adults organised by the Copernicus Science Centre. Furthermore, the Ministry of Education in collaboration with Copernicus Science Centre organises 50 smaller events located in smaller cities around Poland with a Mobile Science Centre bringing interactive exhibitions closer to the public. Moreover, the Institute of Geophysics of the Polish Academy of Science organises events related to CS in various topics. The Researchers' Night event is very popular in Poland. Universities are the main organisers of the Researchers' Night as well as of the Festival of Science. The Ministry of Education offers some small grants for researchers to join the two main Polish festivals and implement their activities.

Most of the CS initiatives in Poland are STEM oriented. Galaxy Zoo is about astronomy and the Spring Alive project is about natural sciences and environmental protection organised by NGOs. NGOs hold a more active role in organising CS programmes compared to the research institutions. Projects such as the Galaxy Zoo, which is presented at the Zooniverse platform, are very popular to the citizens as they are very impressive and different from the common CS initiatives. Polish have a strong tradition in astronomy and people are happy to participate in this type of programme. Citizens' engagement in the Zooniverse platform has increased up to 10-15% after the translation of the platform in polish. Today, around 100,000 users in Poland log in this platform.

CS initiatives like the Galaxy Zoo are organised in a way that both researchers and schools are highly benefited. There are some Institutions in Poland that run CS events in collaboration with schools and apply for funding to implement new projects. During the Erasmus+ project, BRITEC, a network of schoolteachers interested in CS was established and many teachers were keen on participating and joining these actions (participating in webinars, inviting scientists and researchers in their classrooms, etc.). Apart from that, there are some teachers' groups quite active on Facebook but there is not a formal platform or another network where teachers can exchange their ideas, advertise their events or other initiatives.

The most popular way to disseminate CS projects and their results is via seminars, lectures, and workshops, while the most common way for CS advertisement is via social media such as Facebook, newsletters and the website of the action or the website of the organising institution.

In Poland, there are special lectures for specific target groups for example for elderly people, for adults, for undergraduate students and for children. It is important to split the topics and design lectures for special target groups. All the events are free but pre-registration is mandatory. It is not common to collect feedback from citizens that participate in the events. Sometimes there is a questionnaire after the event that people are invited to fill but there is not a common evaluation strategy for the projects in festivals or other events. People are willing to engage in the programmes that scientists perform but what is still missing is that citizens don't contact scientists to learn something new or to suggest in topics that they are interested in.

As a suggestion for the OS and CS promotion in Poland is the establishment of a CS national platform. A dedicated platform for CS initiatives and programmes is more than essential to help and motivate people to search for actions and learn about the CS programmes in their area. It is not an easy process to monitor and investigate the topics that citizens will be happy to focus and work on, but it will be the first step to let citizens choose the topic of their interest and give them the opportunity to find what they really want to investigate.

Portugal

Source of information: Desktop research

The national Portuguese CS platform and network (Ciencia Cidada) is under development and currently lists three active projects.

While there is no dedicated funding programme for CS initiatives, citizen science was recognized as a pillar of Portugal's National Open Science Policy in 2016.

Romania

Source of information: Expert interviews with Cornelia Melcu, Mihaela Cucu and Alina Irimia

A Comments on Open Science in Romania

All the OS activities in Romania are carried out by the Unitatea Executivă pentru Finanțarea Învățământului Superior, a Cercetării, Dezvoltării și Inovării (UEFISCDI). The government established a partnership with the UUEFISCDI in the frame of the project "*Increasing the capacity of the RDI system to respond to global challenges. Strengthening the anticipatory capacity for evidence-based public policy-making*". This institution has a strong experience in engaging stakeholders and facilitates the exchange of information regarding OS. UEFISCDI hosts and manages the two major communities of RDI stakeholders, EERIS (https://eeris.eu/) and BrainMap (https://www.brainmap.ro/) platforms. All the stakeholders that receive national public funds for their research are presented on these platforms.

In order to promote OS, the Romanian Government focuses on:

- the elaboration of the national strategic plan for OS,

- analysis of "open access" policies and international exchange of good practices,
- good practices for open access (OA) warehouses,
- intermediation of international expertise (OpenAIRE, EOSC, RDA Alliance, Open Science Policy Platform, cOAlitionS, etc.),
- constant updating with the latest European and global actions for OS,
- understanding the application of international standards for OA,
- understanding the technical implications for implementing the FAIR principles for open data,
- development of the guide for the application of "open science" principles at national level,
- trainings for understanding FAIR principles and those related to Data Management Plans (DMPs) and
- supporting activities for research organisations that develop e-data infrastructures and want interoperability with the European Open Science Cloud (EOSC).

The concept of OS is relatively new for the Romanian scientific and research communities. However, universities, research organisations, libraries and other entities that are connected to the field of research and innovation know that there is a constant evolution of OS at a European level. A change towards an open and effective communication between the researchers and the society is more than essential in Romania.

Government hasn't any specific strategy or national plan for OS, but currently, UEFISCDI, through the Open Science Knowledge Hub Romania (OSKH RO) and the Ministry of Economy and Commerce (MEC) tries to develop the national strategic framework for OS. OSKH RO was established holding a mission of providing national support and being the main link for the international initiatives in the field of OS. Through this hub, UEFISCDI aims at supporting the research and innovation communities, contributing to setting the national agenda towards an open system of research results and contributing to the EU Open Science Strategy. The compliance with the European requirements regarding the open data comes at the first row in Romania and it is already in the process of supporting the overall transition to OS.

Until now, OA and OS have received limited support from the Romanian National Strategy (SNCDI 2014-2020) and the National Plan for RDI (PNCDI III – 2015-2020). The National Strategy mentions OA of research results as one of its priorities, which can be obtained through the following types of activities: a) ensuring access to scientific research from main streams for all research organisations and b) encouraging the publication of Romanian research results, financed by public funds, according to gold "open access" standards. Currently, there are no dedicated funding programmes for OS, but through the National instrument for research funding there are tools that encourage OS practices. In addition, in 2020 all the PhD dissertations since 2016 became OA (more than 7000 full publications were published on a national platform: https://rei.gov.ro/teze-doctorat).

B On Citizen Science in Romania

CS is an important component of OS but unfortunately it is not popular in Romania. It is also the less promoted aspect of OS in the country (e.g., Open Access or Open Research Data). CS is addressed for the first time in the national strategic framework for OS 2021-2027 that is currently under development. One of the proposed actions in

this strategic framework refers to the involvement of researchers and new users (students, citizens, other communities) in OS (CS), namely by stimulating citizen participation in the process of creating scientific information and open innovation. Thus, according to the draft of the strategic proposals, the creation of programmes that address real societal challenges, attract the direct involvement of society, and encourage the participation of science beneficiaries in research.

Moreover, the national strategic framework for OS (which is under development) proposes solutions to adopt an effective way for disseminating scientific results through open access collaborative mechanisms. According to the national strategic framework for OS, procedures and support systems will be developed to support actions such as CS.

During the COVID-19 pandemic, groups of students were involved in research activities aimed at finding solutions for the problems that the health system was facing. A governmental institution, The Authority for the Digitalization of Romania, developed a partnership with a non-governmental independent institution, Code for Romania, whose volunteers developed a platform for COVID-19 dedicated applications, where they collected all the official information about COVID-19 in Romania. The geo-spatial.org platform, developed in 2002 was dedicated to the geospatial specific instruments, recently started to monitor, and collect relevant information about COVID-19 at a national level with the support of volunteers making it available to the community as an interactive map.

Noaptea cercetătorilor project (https://eu-citizen.science/project/98) is another CS programme in Romania in the field of research which is funded by the European Commission. CS activities are mainly promoted by Open Science Knowledge Hub Romania and some universities, such as the University Alexandru Ioan Cuza in Iasi.

OS is really important for the whole society, and it should promote awareness and motivation to the citizens. OS could make STEM subjects more interesting and inspire students to study them or follow a STEM career path in the future. CS should be part of the national schools' curricula to prepare the young generation to be active and responsible citizens.

Russia

Source of information: Expert interview with Alexandra Borissova

A Comments on Open Science in Russia

The topic of Open Science is pursued in Russia mainly driven by the international movement (e.g., international publishers) and out of several individual researchers' interest in this agenda. So far, Russian publishers have been observing the developments rather than playing an active role. There are no government policies or documents and initiatives in this area. However, GitHub as an open data platform and pre-print servers such as arXiv are used by some researchers. Life Sciences seem to be the leading sector in this as the use is perceived as less common in other areas of science, e.g., Physics or Chemistry. CyberLeninka stands out as a popular Open Science initiative in Russia, an NGO sci-hub providing open access to over 900000 scientific publications, encouraging graduates to upload their dissertations, and advocating for a general Open Science paradigm shift in Russia. During the Covid-19 pandemic, some efforts were made to make public health data open and accessible to everyone; there also were some collaborations between scientists and journalists in

the field of data visualisation. A significant challenge though has been that all efforts rely on the government to provide data on public health regularly and this has not been reliable throughout the pandemic. The Ministry of Education held roundtable discussions with experts in the fields of Open Science and Citizen Science. So there is awareness of both, but no real policy, funding programmes or institutional support.

B On Citizen Science in Russia

While the term Citizen Science is not very well known in Russia yet, there are several examples of Citizen Science programmes, some with a long tradition, especially regarding nature observations. The programmes are often initiated and run by independent nature conservation societies though some of them have close relationships to the government or other political institutions, e.g., the Russian Geographical Society where Vladimir Putin is the head of their Board of Trustees and Defense Minister of Russia Sergey Kuzhugetovich Shoygu is the president of the society or BirdsRussia where many members of the Ministry of Natural Resources as also active members of the organisation. This form of patronage of organisations by high-ranking government officials is very common in Russia; this practice has more to do with the prestige and the funding than with any personal interest of the involved people in the agenda of the organisations. There are also more informal ways people in Russia engage in Citizen Science activities, e.g., people contributing nature observations to iNaturalist. Some STEM enrichment activities in formal education are mistaken for Citizen Science or sometimes even claim to be Citizen Science projects, yet they do not generate any new knowledge instead their focus is on including practical experimental tasks as educational tools to enhance science lessons. The activities sometimes involve parents but usually do not involve professional scientists. There are examples of passive involvement of citizens in neurobiology, psychology, economy, or sociology research, meaning that people are the objects of the research. Some of those studies, however, require participants to monitor themselves, wear certain devices and may potentially allow participants to engage in additional ways in the study. It is very uncommon though that those projects see themselves as Citizen Science.

In linguistics research, Russia has a tradition of large-scale public involvement in research. Those projects often become quite popular due to coverage in popular science magazines or digital science media. One example is a research project where citizens share their variations of a well-known traditional children's poem and based on the regional variations that can be collected this way, the researchers study historical migration within the Russian population. These kinds of research studies have also been initiated by science journalists that found an interesting subject and then collaborated with researchers.

In October 2020, the national Citizen Science platform (www.citizenscience.ru) was launched by AKSON. It aims to provide information on all Citizen Science projects in Russia and to actively engage in the process of developing new Citizen Science projects, especially large-scale projects (e.g., on water quality, satellite images), in collaboration with researchers. AKSON is the Association for Communication in Education and Science and its science communicators, including science journalists, first picked up the Citizen Science trend in other countries, then scoped the Russian Citizen Science landscape and published a green paper on Citizen Science.

This green paper discussed, for example, the issues with the Russian term for Citizen Science. The literal translation of "citizen" means "civil", and this would then refer to all research without military purpose. People who are already involved in Citizen Science activities seem to prefer this literal translation as they are already familiar with the

concept of Citizen Science, but for most of the general public, the term translated as "Civil Science" could be irritating and therefore hinder raising awareness of the Citizen Science concept and opportunities to participate. AKSON got the grant to develop the platform from the Foundation to support civil society and together they settled on a term that literally translates to "Scientific Volunteering" and frames Citizen Science as a movement of scientific volunteers. The term, however, is also not ideal as this Russian term for volunteering was used for voluntary enlistment into armed forces during war. But this connotation is more predominant in people of older generations; for younger people the term is interpreted more broadly for any form of volunteering. The broader interpretation though is used for an established system of volunteering in social and welfare contexts and the Citizen Science community want to be respectful to this community as it is still an ongoing discussion on whether Citizen Science activities could be accepted as a form of volunteering for the benefit of society as well. This could mean that participating in Citizen Science could be acknowledged in the same way as social and welfare volunteering (e.g., as credit for university applications, volunteering pass).

The Citizen Science platform with its expert board decided intentionally to not exclude any of the terms and instead communicate a broad and inclusive understanding of Citizen Science. It also uses the English term Citizen Science in its URL and on the website, here written in Cyrillic script though. The intention to be inclusive is also reflected in the branding using the term "people of science" for the Citizen Science community and the logo (a lab glove as a balloon, symbolising a helping hand reaching out). In general, the definition the platform follows is that Citizen Science are research activities involving non-experts in that respective field. But the platform does not want to assess if activities are Citizen Science or not. For the Citizen Science projects that are developed by or in collaboration with the platform, the aim is to enable a high degree of participation for Citizen Scientists and to involve professional scientists as an indicator for scientific quality. But for the purpose of listing existing projects on the platform, a broader understanding of Citizen Science is applied. However, marketing research or surveys that do not require any personal input, where it does not matter who and where the person is, are excluded from being listed on the platform. It now also provides the infrastructure for large-scale projects (e.g., the interface for data submission) and the institutional support for Citizen Science in general, something that had been missing so far.

There are currently no dedicated funding programmes for Citizen Science in Russia. Some projects are funded by other research grants that the project leads hold, by science societies often for conservation purposes or through corporate social responsibility units from companies often for entertainment and engagement but green-washing and positive media coverage may also play an important role.

Personal opinion: As a "former" scientist, I see Open Science as part of a broader movement to reform the current system of closed peer-review journals. This system is not up to date, not fit for purpose anymore, and it must change, and this change is now taking shape. As a science communicator, I see benefits and risks. We all know and love the benefits. But when research immediately becomes available for the public, it may lead to self-censorship as scientists are aware of how some results can be misinterpreted by the public and not be assessed in the correct context (e.g., research about vaccines, small sample sizes). As for Citizen Science I don't see many drawbacks, it's more complex and resource-intense than one might expect. In addition to all the benefits to scientific research and educational benefits for participants, it's a really good way to change the attitude of scientists towards the

society and how they can realise that engaging with the public should be part of their work.

Serbia

Source of information: Expert interviews with Biljana Kosanovic and Tanja Adnađević

A Comments on Open Science in Serbia

In Serbia, the OS concept is on the rise. As it is not mandatory but recommended, some stakeholders perceive that it shouldn't be implemented. The Universities within Serbia as well as the Ministry of Education and Science are trying to promote OS as much as possible via international, Horizon 2020 and Erasmus+ projects. Responsible Research and Innovation (RRI), same as OS, doesn't get the appropriate attention in Serbia. On the other hand, the Ministry has set up an OS dedicated office in coordination with four major universities in the country. During an Erasmus+ project, an OS platform was established in Serbia. The Ministry of Education is actively trying to implement OS and promote its values to the research community by organising several seminars for OS promotion.

Another action is the Open Science Days. This is a face-to-face event taking place every 2 years in Belgrade with more than 350 participants. It can be characterised more like a seminar and all the participants are invited to attend this event. The participants of this event are mainly librarians, researchers and all those who support and work on science, data management, science evaluation, etc. In 2020, Open Science Days event was organised online in November.

OS is a reality both in academia and in research organisations in Serbia. Starting with the OS policy level, Serbia follows the OpenAire recommendations. There are a few initiatives and groups within Serbia that work on the OS direction:

- OpenAire-NOAD initiated most policy actions at national level
- Universities/research institutes that follow Government's policy
- Editors of local scientific journals, with the support of SCIndeks (Serbian citation index) which is the central hub of the integrated system for quality-controlled scientific publishing in Serbia. Through this initiative and through the site: http://doiserbia.nb.rs/, 102 journals are indexed by DOAJ. The local scientific journals couldn't survive without the financial support of the government. All the local journals are now open access.

Some key actions about OS in Serbia are presented below:

- In 2014, the government boosted the establishment of a national repository containing all the national PhD dissertations (more than 10.000) https://nardus.mpn.gov.rs/contact
- There is an OS platform in Serbia dealing with open access and open data and it is available also in English.
- There is a document about Open Science Policy in Serbia found in the https://open.ac.rs/ website, which enhances the discussion with the universities to promote the OS in the country.
- In 2018, the government announced a new Law in order to include OS in the Serbian National Science and Research section.
- In the beginning of 2020, the government formed an official group forOS in Serbia, called TONuS. TONuS group consists of more than 25 people, 5 of them are people coming from the top level positions of the Ministry of Education,

Science and Technological Development and the rest are researchers and especially young researchers. https://www.openaire.eu/blogs/aligning-the-development-of-open-science-in-serbia-with-european-initiatives

- Serbian Academy of Science and Art is another organisation in Serbia which is very active regarding repositories. Thousands of documents belong to their repositories, and it is surprising how many people are reading these articles.
- In the STEM field, scientists are already aware of OS. Many of them participate in EC projects and know how to disseminate their results to the general public. Furthermore, STEM Faculties seem to understand OS better compared to the Faculties of Social Sciences or Humanities.
- The last 2 years researchers and especially those that engage in EC projects approached Librarians and they asked for help in research data management processing. There is a small grant from EOSC Co-creation Budget to support the research data management activity in Serbia and in the neighbouring countries (Croatia, North Macedonia, Montenegro, and Bosnia). A new group for research data management established within these countries. This group is very active putting effort towards the open access direction. All these actions presented above highlight the plan for OS promotion in Serbia.

B On Citizen Science in Serbia

There are many CS activities organised in Serbia. They are usually called CS projects or CS workshops, but there are several other synonyms that have been used depending on the programmes' organisers. The most popular term used is *participatory projects*. Some of the CS initiatives in Serbia are presented below:

- Researchers' Night is very popular in Serbia and many young people attend this event. This event is in many cities in Serbia and many scientists participate and present their scientific research and results. Media promotes the event which attracts many attendees. The Centre of the Promotion of Science (CPN https://www.cpn.edu.rs/en/) is a public institution which is funded by the government and organises many events especially for children as well as the Researchers' Night event. The Centre of the Promotion of Science is involved in many European scientific projects and CS projects such as, the H2020 Terrifica project which is dedicated to climate change (https://terrifica.eu) and the RRING project (https://rring.eu/meetings-events/). These projects are related to the policy level and the Science responsibility. All the events are open and free to the audience.
- Universities organise events for the general public such as open days. They also organise an event called EDUFair. Some universities have started organising some CS programmes. University of Novi Sad started a CS project during the COVID-19 crisis, which involved more than 1,500 participants. The project was about monitoring people's reactions regarding the COVID-19 pandemic daily. The results of this CS research are published in the scientific journal Frontiers in Psychology (https://www.frontiersin.org/articles/10.3389/fpsyg.2020.02133/full). A web page dedicated to CS has been created on the website of the Centre for Behavioural Genetics (http://www.cbg.ff.uns.ac.rs/volonterska_nauka.php text in Serbian). University of Nis started the OpenClick project about Alzheimer disease (http://www.openclick.rs/index.php/en/home-en-gb/news. The application is available at http://openclick.masfak.ni.ac.rs/#/).
- There is a special TV channel, TV Brainz, https://brainz.center/, which is dedicated to popular science (does not have any programmes available in English) and it is addressed to the general public.

- Belgrade Open Schools is an NGO and it organises ecology actions about air pollution and noise pollution. Citizens actively participated in the noise pollution project measuring the noise around the cafes and the pubs in Belgrade.[16]
- UNDP office in Serbia[17]
- Museum Night event: https://www.nocmuzeja.rs/o-nama/in-english. Libraries also participate in this museum event especially in the cities where there are no museums, and the libraries are the main cultural hub.

CS projects are implemented in several different formats (workshop, talk, seminar, fieldtrip, etc.) to attract and engage as many people as possible. They do not follow the "one size fits all" model, but they try to approach different target groups with different types of events. The most popular CS activities belong to biology and bird watching. There are also several CS activities devoted to climate actions, light pollution, and astronomy. CS activities have a different impact depending on the project. For instance, Bird Protection and Study Society of Serbia CS projects have high impact as well as high responses and engagement from the citizens and the communities. The impact depends also on the type of the project. Noc istrazivaca is another CS project in Serbia (https://nocistrazivaca.rs/en/home). Some governmental organisations are very active in promotion of CS and CS projects. NGOs are also actively involved in organising CS projects.

People are very willing to engage in OS and CS projects when these are presented in an understandable way. Although OS and CS programmes are dedicated to the general public and they are of general interest, there are also some projects that are dedicated to specific target groups. CS activities focus on raising the public scientific awareness (including science education for adults and children) while they participate in the scientific process by observing, gathering, and processing data and/or co-designing and implementing science-related policies. All these activities are of great importance to improve the scientific literacy of the general public and help them develop critical thinking. Unfortunately, the formal education in Serbia does not recognise the CS benefits in students' education and that's why OS and CS don't integrate into the school's curriculum.

The advertisement of CS projects in Serbia is mainly via social media. The CS projects' platforms are also used for the promotion of the project. Each project has its own social media account and especially Facebook, which is widely used.

There are a few CS platforms in Serbia such as: *http://pticesrbije.rs/?lang=en*, *https://carpenoctem.rs/en/home-en-2/* and the OS platform *http://open.ac.rs/*. These platforms are translated in English, and they belong to the public domain. Moreover, there are CS articles/policy papers in Serbia written in Serbian, such as http://open.ac.rs/politika.

The Centre for the Promotion of Science focuses on the promotion of OS and CS in Serbia. A few years ago, there was a huge contribution in the promotion of the RRI but now the focus has been oriented towards OS. The Centre for the Promotion of Science tries to implement every phase of the project highlighting the role of citizens in CS projects, for example citizens' engagement in the data collection phases, in the

16 http://www.bos.rs/ei-eng/projects/442/2018/11/29/you4eu--citizen-participation-2_0.html, http://www.bos.rs/en/news/215/2019/10/08/citizen-science-in-belgrade-new-20-citizens-monitor-the-air-quality.html

17 https://www.rs.undp.org/content/serbia/en/home/presscenter/articles/2019/nagra_eni-pobednici-drugog-kruga-izazova-otvorenih-podataka.html

development and results phase, etc. RRI is not fully accepted in Serbia, but there is a significant acceptance regarding the OS and CS. The Centre for the Promotion of Science organises activities and people get informed through the PR team, but also through the mailing list of followers and the mailing list of schools. All the activities that the Centre for the Promotion of Science organises are free- access to everyone.

Slovakia

Source of information: Expert interview with Silvia Horakova and Zuzana Stozicka

A Comments on Open Science in Slovakia

In Slovakia, there is no national or institutional policy regarding OS nor a national OA repository. Some small repositories are mainly used for institutional needs by the universities' departments. This year a National OS Strategy is about to be adopted and this is one of the main tasks of the Open Government Partnership Action Plan for 2020-2021. National OS Strategy is focusing on OA publishing, policies, FAIR data and DMP, OS as part of the educational process, changes in evaluation of scientific staff and CS.

OS is usually promoted by non-governmental organisations, researchers in universities or by the Slovak Academy of Sciences. The OS project Enviróza is implemented by the Slovak Environmental Agency, while the Open Government Week is organised by the Office of the Plenipotentiary for the Development of the Civil Society.

Slovak Centre for Scientific and Technical Information (SCSTI) is usually the coordinator of OS activities in the country. SCSTI organises conferences twice a year (spring and during the OA week) where around 50 - 100 people are participating, 3 - 5 webinars per year where around 50 people are attending and courses 2-4 times per year where around 10 people per course are participating. When the first OS activities launched in 2016 were dedicated to librarians.

The spring conference is usually dedicated to OA journals editors in Slovakia, the conference during OA week is dedicated to librarians and researchers, the webinars are open to everyone who is interested in the topic (librarians/researchers, etc.) and the courses are dedicated to librarians, researchers, and students.

OS is a way to solve many current problems in educational communication and the open practices can increase the integrity of the research. Part of the academic community is still bound to the traditional practices of science communication, and they continue using them until the system of research evaluation changes reasonably. CS has a big potential to bring the best in the society matching the two words, science, and citizens in connection with healthy research environments.

B On Citizen Science in Slovakia

CS is not widely known or used in Slovakia, despite all the efforts to change this direction. The CS activities in Slovakia are usually called Občianska veda - citizen science. When organisers don't use the term CS, they call the activity by its topic or title (e.g., Winter waterbird count). Some non-governmental organisations (mostly involved in nature protection) engage people in CS activities (e.g., monitoring of bird populations or increasing biodiversity on urban grass fields) without using the CS term. Only a few projects use this term, for example the Enviróza project (students help to localise illegal waste disposal - http://www.enviroza.sk/), the Visitor project (monitoring of the invasive species via a mobile application, http://visitor.sav.sk/#/home) and the Occurrence of the Aesculapian snake in Bratislava project (people that join through

the project's Facebook group help herpetologists to monitor the target species). The projects are promoted on internet (webpages are dedicated to make science more popular using interest groups on social media), or through open public talks (e.g., there is a library event, the "Scientific café", where the invited scientists talk to the public about their research in a more relaxing atmosphere). There are social media accounts dedicated to particular CS projects, such as the Occurrence of Aesculapian snake in Bratislava[18] or the Mapping of the turtles in Slovakia in Slovakia[19].

CS perspective is only exceptionally included in scientific programmes in Slovakia. Libraries, conferences, cultural venues, and some environmental non-governmental organisations organise outdoor workshops to promote CS in the country. Biology and environmental protection are the most popular CS topics in Slovakia. Children as well as adults are engaged actively in CS projects while they conduct science themselves (this is part of the process to understand the scientific results of the projects).

The Contact office for Open Access is the Slovak Center of Scientific and Technical Information that participates in the promotion of CS, looking for CS projects in the country and inviting CS stakeholders to discuss with them. The Office of the Plenipotentiary for the Development of the Civil Society supports the whole idea of OS including CS.

Officials, researchers, and other key stakeholders (apart from the entities that spread distrust to anything scientific) agree that the society needs to be knowledge-based to succeed in solving the current economical, healthy, and societal problems. The current connection between the public and science is weak, public support of science is low and people often do not believe that Slovak science makes anything good for them. Slovaks also believe that it is not important to invest the taxpayer's money in research. Moreover, scientists often think that the general public is unable to contribute with valuable data and it is too hard to be motivated. Most of the discussions about this issue find public engagement in science a good idea to reduce the conspiracy theories that many people believe in.

Most of the academics do not promote CS (partly because they don't know what it is), but there are some academics who are involved in science communication. Science festivals are organised by active groups, individuals, and scientific non-governmental organisations. People usually find these events very interesting. European Researchers' Night is quite popular, and it is organised by the non-governmental scientific organisation SOVVA. One of the biggest festivals in Slovakia is the "Week of science" (associated with a competition of student projects) organised by the Slovak Center of Scientific and Technical Information. Universities take part in this event. Many of the people that are involved in the organisation of the scientific events are working in universities or at the Slovak Academy of Sciences.

Many scientists still think that open access publishing is equivalent to the gold (APC) business model and claim that they have no money to spend on open access journals. To change the current situation of OS and CS in Slovakia the potential project leaders should be trained and informed as well as having support and better funding opportunities.

[18] https://www.facebook.com/ZamenisBA/?__tn__=%2Cd%2CP-R&eid=ARCtQ7Ekehi22LQ0gO2h0SoiOWcFG5yiv4TRqBLCJKwLU3lVmmAzyCUoIsLK_ZQhdP0Owicl6PYJyU7j

[19] https://www.facebook.com/Mapovanie-korytna%C4%8Diek-na-Slovensku-107412137305182/

The best way to promote OS and CS in Slovakia is by raising citizens' awareness and promoting existing projects in the country underlining that CS can benefit both scientists and the general public. The Open Government Week, which is a program about CS with three speakers from Slovak CS projects, can definitely help in the CS promotion in Slovakia. The establishment of a CS platform is also very important for citizens who are interested in CS projects (find information about CS in Slovak language, read CS success stories, find out how to participate in active CS initiatives) and also for scientists (to find out how to design and implement a CS project, etc.).

The current situation of CS in Slovakia is not mature enough to result in a national level impact. Many systematic efforts must be done, such as to inform the general public of CS and how they can join CS actions as well as inform all the stakeholders how they can benefit from CS. The scientific community in Slovakia should be more open to know about the CS advantages and bust myths like "it is not scientific enough", "data from citizens will be flawed", or "there is no way to get paid for such work", "how to find funding for it" and "how to work efficiently with public".

Slovenia

Source of information: Expert interview with Jurij Krpan

A Comments on Open Science in Slovenia

Open Science is more of an informal topic in Slovenia. Most of the OS events are organised by the NGOs (Kersnikova Institute, Institute 404, House of the experiments, etc.) which are trying to bridge the gap between fundamental science and the broad audience. Most of the OS events come in the form of education and skills development and they are designed for specific target groups, mainly for children and youngsters. STEM fields are specially promoted by the NGOs and most of the events are related to STEM topics.

More EC calls for OS, open education, CS for artists and especially calls for researchers will definitely help the OS promotion in Slovenia and in Europe at large. It is very important to have projects that can guide scientists towards an OS-oriented future and educate them how to be closer to the citizens, making their science understandable and more approachable to everyone. If the government focuses more on organising seminars about OS it will also be positive for the scientists and the general public towards this direction.

B On Citizen Science in Slovenia

The CS festivals in Slovenia are mainly organised by the NGOs. There is not a Science Museum in Slovenia but there is a plan to have one in the next few years. NGOs are trying to collaborate with universities and research centres as well as with scientists and researchers. The Slovenian government supports Open Education, but it doesn't focus on OS. The only call dealing with OS is the one that supports the Night of science, the biggest science festival in Slovenia, and the funding usually goes to the NGO that organises it, which is the House of experiments. All the other calls that are connecting art and OS are coming from European funded projects. There is a slight support from the Ministry of Culture but there is no support from the Ministry of Education, Science and Technology.

In Maribor, which is the second biggest city in Slovenia, and in Ljubljana, the Night of science festival is organised every year. There are other festivals such as the

international festival for Computer Art in Maribor, the Speculum Artium festival in Trbovlje, the Pixxelpoint in Nova Gorica, the Earth without humans in Ljubljana, etc. These festivals are all about art, science, and technology.

Kapelica Gallery managed by the Kersnikova Institute, is an artistic organisation where artists can develop their artwork using living organisms (cells, bacteria, microorganisms, and tissues) under a broad topic that it is called artificial life. According to specific artworks and their disciplines, artists are contacting and collaborating with specific institutions. Lately there is cooperation with one of the best scientific platforms called Institute for Chemistry to establish an in-house living lab. The plan is to develop artworks in the living lab bringing together engineers and scientists that will sporadically work in interdisciplinary topics and bring science closer to the broad audience (do some workshops, lectures, science cafes and presentations). The workshops and the activities are addressed to all ages.

The workshops include hands-on activities dealing with contemporary technologies, information technology and electronics as well as with biology and biotechnology. Most of the workshops are in-house, but artists and scientists are also visiting schools and perform their workshops there. Artists are systematically trying to collaborate with schools, but it is very challenging. They are trying to collaborate with the Institute for Education Development, but it is very difficult to succeed. Probably more than 10 years are needed to develop a standard collaboration with teachers and teachers' networks. The Ministry and the schools don't understand the actual benefits of informal learning, and there are only a couple of schools that really want to join the projects and collaborate with the organisation.

Kapelica Gallery participates in 8 active European projects at the moment. These programmes belong to creative Europe, Horizon 2020 and the biggest project is coming from the European cohesion Policy. They usually advertise their events and workshops through the newsletters and the mailing list, the social media, and the projects websites. Citizens are a little bit afraid of the topics that they present as they consider them as avant garde. On the other hand, there are people that follow them and visit their workshops for 8 or 10 years in a row and this is something very important.

BioTehna project is aimed at artists, scientists and the general public who wish to artistically research living systems. Two different kinds of lab-books are produced for these workshops. There is a printed version and a video tutorial. The organisation is working in this direction to produce lab-books and video tutorials to promote this sharing culture to the people. They have also published 15000 copies of a printed version of a comic book developed in the Chaos Computer Club (CCC) in Berlin, about artificial intelligence titled We Need to Talk, AI**.** It is also in a digital form in a pdf format[20].

The best feedback received from their events is the audience's attendance. Every time they advertise a new workshop, it is always fully booked within 20 minutes. This is something really important to showcase that the demand is bigger than what they can really offer.

Another CS event that they have established is a programme called Friday Academy and it takes place every Friday. The Friday academy is now so popular that they run it 4 times per week. It takes place every day apart from Tuesday when a women's community, called Cipke, organise their events and they also produce great results.[21]

[20] https://weneedtotalk.ai/

[21] https://beepblip.org/2013/11/11/cipke/

Another slot is the five Hack Academy which is a week-long event and takes place twice a year. The workshops are thematic, for example participants build their own microscopes, they create their incubators and laminariums and they grow their own bacteria treating them with antibiotics. All the events are free apart from the Hack Academy (where people are charged only for the meal provided).

There is a general belief that scientists that collaborate with artists are considered by other scientists as non-serious professionals. Embedding art and science is something unusual for universities and research institutions. Young people are more willing to collaborate with artists these days than in the past, but society isn't ready yet. Researchers are closed in their labs and their bubbles, hidden in their research, their papers and proposals focusing more on their careers.

Spain

Source of information: Desktop research

FUNDACIÓN IBERCIVIS [IberCivis Foundation] (https://ibercivis.es/) private non-profit foundation whose objectives are to carry out, promote and make CS visible through the

OFICINA DE LA CIENCIA CIUDADANA EN ESPAÑA [Citizen Science office in Spain] association (https://ciencia-ciudadana.es/). Co-financed by the Spanish Foundation for Science and Technology (FECYT) and the Ministry of Science and Innovation

The Spanish Foundation for Science and Technology (FECYT) also offers funding opportunities for citizen science projects as part of its grant programme for the promotion of scientific, technological and innovation culture.

CENEAM (Centro Nacional de Educación Ambiental) - [National Center for Environmental Education] - Ministry for Ecological Transition and Demographic Challenge - Environmental Education Program (https://bit.ly/2NJYelX)

NATUSFERA Adaptation of iNaturalist - Financed by FECYT (Spanish Foundation for Science and Technology), Obra Social "La Caixa", the National Node of Biodiversity in Spain, GBIF.ES (www.gbif.org) and The Institute of Marine Sciences (https://natusfera.gbif.es/). It contains guides to learn about biodiversity around the world. If you register, it gives you the possibility to create guides

AEMET (Agencia Estatal de Meteorología) - MINIMET [Meteorology Statal Agency] - Initiative that integrates the following concepts: education, crowdsourcing, citizen science and the Internet of Things (IoT) (http://es.minimet.net/)

Regional offices such as "Oficina de ciència ciutadana" in Barcelona

Switzerland

Source of information: Desktop research

Switzerland belongs to the countries having a large platform on citizen science. The CS platform "Schweiz forscht" (Switzerland does research) which offers an overview of a high number of projects on different topics such as society, climate, language and the universe as well as information on citizen science and the national network

in Switzerland. In Switzerland there is also the Citizen Science Center Zurich and the Participatory Science Academy.

Ukraine

Source of information: Expert interview with Dmytro Khutkyy

A Comments on Open Science in the Ukraine

Open Science is a complicated topic in Ukraine. Although some organisations have repositories with open access documents, most of the publications remain in hardcopies only. The Ministry of Education deals with OS and library specialists in universities who serve as the coordinators of OS programmes-actions. Seminars regarding OS promotion in universities are held by librarians and most of the OS programmes are dedicated to academics. Only the researchers in universities are interested in science communication and want to promote their scientific work. Promoting open access publications and shifting researchers' opinions towards publishing under open access licences is more than important for OS establishment in Ukraine.

B On Citizen Science in the Ukraine

Most of the CS events in Ukraine take place in schools. The online voting in participatory budgeting projects is the most engaging type of activity for high-school students and adults. People get informed about CS events mainly online via social media. All the events are free for the general public.

United Kingdom

Source of information: Desktop research

In the UK, activities conducted under the umbrella term citizen science are quite wide-spread. UKRI, the UK's national public agency for funding science, research and innovation, is funding a grant call for Citizen Science Collaboration - the UKRI Citizen Science Collaboration Grant

A lot of research organisations, institutes, charities and museums across the UK also have citizen science platforms. There are institutes among them like the Institute for Research In Schools (IRIS) or the Centre for Ecology and Hydrology, charities and museums as the Natural History Museum, the British Science Association, Wildlife Trusts, the British Trust for Ornithology, the Bristol Natural History Consortium or the Open Air Laboratories (OPAL), and there is even a research organisation called Extreme Citizen Science (ExCiteS) at UCL. A lot of universities such as The Open University engage in citizen science.

United States of America

Source of information: Desktop research

In the USA, we find a diverse citizen science landscape. On the one hand, citizen science is a means for the American government to fulfil its tasks. On the other hand,

we also find grassroots projects in the USA that can be described as citizen science from a European perspective, although the term is controversial in the USA (see a discussion of the controversy in Strähle, Urban, Anastasakis et al., 2021, pp. 27-37). These can be projects initiated by citizens' initiatives, but also projects that originate in academia, certainly also in the context of service learning for students, and in Europe partly fall into the area of action research (community - based research). Precisely because citizen science also serves to fulfil government tasks in the USA, we also find a legal anchoring of citizen science in the Crowdsourcing and Citizen Science Act (15 USC 3724). In this, which is perhaps somewhat surprising from a European perspective, a distinction is made between citizen science and crowdsourcing, whereby citizen science is understood to mean that parts of the public voluntarily participate in scientific processes, and crowdsourcing is seen as a voluntary mass participation of Americans that is used to tackle complex challenges through research at large geographic scales or over long periods of time, because professional scientists alone are not able to do so. This includes, for example, weather observations, as we know it from Europe. Government-related citizen science projects usually originate from federal agencies. NASA certainly makes the most use of citizen science, but the National Oceanic and Atmospheric Administration (NOAA), which is responsible for weather observation and oceanography, the U.S. Geological Survey and the United States Environmental Protection Agency also organise their own citizen science or crowdfunding projects. The legal basis for this is the above-mentioned Crowdsourcing and Citizen Science Act. The implementation of this policy is being evaluated, as a report by the Office of Science and Technology Policy shows (Office of Science and Technology Policy, 2019). Even at NASA, which partly implements and partly funds citizen science projects, the focus of these projects seems to be on the environment in the broadest sense.[31] This is evident in the agencies that organise or commission such projects, on the one hand, and in funding, on the other. For example, the US Department of Agriculture has its own funding programme for Citizen Science (Citizen Science Competitive Funding Program)[32] and the National Environmental Education Foundation, which works complementary to the United States Environmental Protection Agency (EPA), funds projects for environmental education as well as for the preservation and rehabilitation of the environment, i.e. under the title "Citizen Science" also projects that do not directly pursue scientific but rather social goals, and also organises its own projects.[33] There do not seem to be any funding programmes for citizen science projects that originate in academia or citizens' initiatives; in this case, additional research would have to be done to find out what funding opportunities are offered by private foundations.

Accordingly, there is a great deal of information available on what citizen science is, what funding opportunities are available for it and where one can get involved. citizenscience.gov, the official website of the U.S. government on citizen science and crowdsourcing, provides information on current and past projects, how to get involved, and how to successfully organise and carry out such a project (similarly, the Department of Agriculture and the EPA). The U.S. General Services Administration maintains the Federal Community of Practice on Crowdsourcing and Citizen Science for federal agencies.[34] The agencies themselves present opportunities to participate

[31] https://science.nasa.gov/citizenscience

[32] https://www.fs.usda.gov/working-with-us/citizen-science/competitive-funding-program

[33] https://www.neefusa.org/education/citizen-science

[34] https://digital.gov/communities/crowdsourcing-citizen-science/

on their websites, and not just about those on their own projects.[35] Media such as the Public Broadcasting Service[36] and the Scientific American[37] also provide information.

The USA is also home to most of the well-known citizen science and crowdsourcing portals. On SciStarter, there are more than 3,000 participatory projects, again mostly in the field of the environment.[38] eBird, based at the Cornell Lab of Ornithology, collects observations from professional and recreational birdwatchers from all over the world (primarily from the global North) via an app and makes the data available on the portal.[39] Like SciStarter, iNaturalist, owned by the California Academy of Sciences and the National Geographic Society, has grown out of a university student project. The portal collects and presents biodiversity data collected by volunteers from around the globe.[40] Zooniverse, which claims to be "the world's largest and most popular platform for people-powered research" is a British-US joint venture.[41] - Even a cursory glance at these platforms shows very impressively how strongly those who participate in them are based in the global north, even if the projects see themselves as global.

Science museums in the USA are also involved in citizen science, e.g., the North Carolina Museum of Natural Sciences[42], partly for auxiliary science activities to save resources, partly to collect data that a museum cannot collect itself, partly to teach science education in schools. A particularly noteworthy programme combining citizen science with science education is the Global Learning and Observations to Benefit the Environment (GLOBE) programme.[43]

Sponsored by NASA, NOAA, the U.S. Department of State, and the National Science Foundation, the programme supports projects in over 100 countries worldwide.

With the Citizen Science Association[44], the citizen science community in the USA has a network, an advocacy group and a scientific platform that holds an annual scientific conference and publishes an internationally respected open access journal, Citizen Science: Theory and Practice[45].

Asia

Source of information: Desktop research

For Asia, the search for citizen science platforms, policy papers, funding programmes, citizen science networks and opportunities to participate in citizen science projects

[35] See, e. g., the EPA (https://www.epa.gov/citizen-science/how-find-citizen-science-projects) and NOAA (https://oceanservice.noaa.gov/citizen-science/).

[36] https://www.pbs.org/wgbh/nova/labs/

[37] https://www.scientificamerican.com/citizen-science/

[38] https://scistarter.org/

[39] https://ebird.org/home

[40] https://www.inaturalist.org/

[41] https://www.zooniverse.org/

[42] https://naturalsciences.org/research-collections/citizen-science/current-projects

[43] https://www.globe.gov/about

[44] https://citizenscience.org/

[45] https://theoryandpractice.citizenscienceassociation.org/

yielded very different results. The search was primarily for online sources in English and Chinese. The Middle East, which was analysed separately, was excluded. Due to the language limitations and the restriction to online sources, it cannot be excluded that citizen science networks, policy papers, funding programmes, opportunities to participate in citizen science projects and citizen science initiatives exist about which no information is available in English or Chinese. Another limitation is that there are probably citizen science-like initiatives in different countries that do not call themselves such. An example of this is Japan, where the term "citizen science" has connotations of political activism and is therefore avoided by some so as not to be suspected of having primarily political rather than scientific objectives (Kenens et al.,). Sources were found in India, Japan, Singapore, China, and Taiwan. In Asia, there is a citizen science network like the European ECSA and the US-American CSA, CitizenScience.Asia. The network is based in Hong Kong in **China** and has an English-language web presence on Facebook, Twitter and Medium[46]. The activities and information listed there over the years largely relate to participation in events organised by UNEP and UN-affiliated agencies, events in Hong Kong and webinars with scientists from Japan and Taiwan. The projects reported on are in the field of biology, especially zoology, with a clear biodiversity focus. This includes DIY biology. In Hong Kong, the Make a Difference Foundation initiates participatory research in general and citizen science via the Make a Difference Social Lab[47].

In **India**, the Center for Citizen Science aims to promote citizen science in India and thus to solve various social, environmental issues. The centre, which is supported by volunteers and scientists from various disciplines, sees itself as a bridge builder between research institutes and society in general and claims to have initiated many research projects in which citizens and researchers work together.[48]

In **Singapore**, the National Parks Board offers to participate in various citizen science projects initiated by national parks, and there is also a citizen science programme for schools, which is also supported by the National Parks Board.[49]

As already mentioned, in **Japan** the term citizen science has connotations of political activism. Although there is an internationally known citizen science initiative (SAFECAST) there does not seem to be a citizen science network that calls itself such. Remarkably, there is a private funding programme for citizen science projects, the Takagi Fund for Citizen Science, which supports citizen science projects not only in Japan but throughout Asia.[50] The funding database lists projects in Bhutan, India, Cambodia, Korea, China, Indonesia, Thailand, the Philippines, and Turkey, among others. The focus seems to be on grassroots projects with environmental objectives.

In **Taiwan**, there are several citizen science platforms and portals, such as the Taiwan Environment Information Center (e-info) - an NGO -, the government-run Taiwan Biodiversity Network (TBN) and the portal PanSci. E-info informs about citizen science

[46] https://www.facebook.com/CitSciAsia/, https://twitter.com/citsciasia, https://medium.com/citizenscience-asia

[47] http://www.mad.asia/programmes/mad-social-lab

[48] http://citizenscience.in

[49] https://www.nparks.gov.sg/biodiversity/community-in-nature-initiative/citizen-science-programmes

[50] http://www.takagifund.org/index.html

projects on its website[51], PanSci[52] and TBN[53] draw attention to opportunities to participate in citizen science projects. PanSci is supported, among others, by the state-run Endemic Species Research Institute, which, according to PanSci, has been promoting citizen science projects since 2009. A comprehensive spreadsheet on Google Drive[54] also lists numerous citizen science projects in Taiwan, so it can be assumed that the citizen science landscape in Taiwan may be more vibrant than the sources mentioned suggest. Citizen science projects appear to focus on biodiversity and environmental monitoring, e. g. on measuring air quality or the observation of insects. In its White Paper on Science and Technology 2015 - 2018, the Taiwan government writes: "While pushing forward the smart green buildings promotion projects, the Government is committed to facilitating the joint participation of citizens and government officials at the local level in furtherance of low-carbon urban/rural ecological environment projects" (Ministry of Science and Technology, 2016, p. 170). Does this include citizen science? Generally, the document mentions that citizens shall benefit from R&D and science education. The National Science and Technology Development Plan (2017-2020) presents a similar reasoning (Ministry of Science and Technology, 2017).

[51] https://e-info.org.tw/taxonomy/term/47374

[52] https://pansci.asia/tw-citizen-science

[53] https://www.tbn.org.tw/participation/participation

[54] https://docs.google.com/spreadsheets/d/1HHWRfFEb7GOvacjEpZbNfNP2Le74wvEiAAtTidWRoco/edit#gid=0

4 Shedding light on some open questions in citizen science

Michael Strähle & Christine Urban[64]

4.1 Introduction

Despite there are thousands of publications on citizen science, project presentations and case studies outnumber systematic empirical research and conceptual clarifications by far. The knowledge gaps on citizen science are considerable. Just to name the maybe most important one: We do not know who takes part in citizen science. However, if we do not know this, how can we claim benefits such as increased science literacy among participants in citizen science activities? This is one of the findings of the literature reviews that are published in Deliverable D1.1. Among other things, CS Track narrows some of these gaps by having conducted a survey (see Deliverable 4.3) and expert interviews. Results of the expert interviews are presented in this chapter and the chapter preceding it.

There have been some solid efforts to evaluate citizen science (see D1.1) but the difficulty is that the many existing concepts of citizen science are often not (fully) comparable. Citizen science activities can be embedded in different environments. Citizen science activities can be a part of an environmental project, an educational curriculum, an initiative of self-help-groups, a social endeavour, science communication, a new form of development aid or something else. It may be more accurate to see Citizen science as part of other projects than to regard them as a whole project by itself. Citizen science can be the dominating activity or even the only activity in a project, but we may also look at combinations of science-related activities and activities that are not related to science or citizen science at all. Which types of knowledge is needed for citizen science depends on what concrete tasks are carried out with which means and in which setting. Depending on these characteristics, citizen science can require so many different expertises to meet, the inclusion of so many knowledge areas inside and outside academia, that it is doubtable that one line of education can prepare a person with all the expertise required. Among others, expertise may be required on (research) ethics and integrity, research quality assessment, social work, health communication, learning strategies and quality assessment in education, on democratic procedures and standards in public participation, on environmental action and group psychology. The Activities & Dimensions Grid of Citizen Science in D1.1 allows for placing each citizen science activity into a scheme to allow for evaluation according to operationalizable characteristics in a variety of respects.

Altogether, we conducted 12 expert interviews. Each expert interview conducted via video conferencing lasted for 40 - 90 minutes. Some experts preferred to answer in writing after we sent them our questions. We were looking for experts with a broader perspective on citizen science who are less known and cited in citizen science communities and matched the qualification profiles instead of interviewing experts who have widely published on a topic or on issues since their views are already

[64] Authors listed in alphabetical order.

published. D1.1 proved that despite much literature on citizen science, we are mostly dealing with case studies. There is a lower number of specialized experts who have systematically investigated different aspects of citizen science. The intense work of these relatively few experts has been systematically reviewed in D1.1, especially to feed the Activities & Dimensions Grid of Citizen Science and led to an extensive literature review. For the many questions that remain unanswered it is wise to tap into other pools, especially in view of the many different knowledge fields that are concerned by open questions.

As stated in the chapter on the methodologies for this report, we were looking for new insights outside of the mainstream of literature on citizen science. The expectation was that the debates on citizen science and the citizen communities at large would benefit from such insights. Consequently, we looked for such "non-mainstream" experts with different backgrounds and experiences in different research fields and geographic areas to learn about their views on citizen science.

CS Track uses the European Commission's broad explanation of citizen science in the Horizon 20020 Work Programme "Science with and for Society" (European Commission, 2018). One of the outcomes of the literature reviews conducted for D1.1, is a list of knowledge gaps we identified and formulated as potential research questions (see D1.1, chapter 9). Many of these identified gaps are in research ethics and integrity, and several ones concern the conceptualisations of citizen science and how citizen science is understood. Bearing this in mind, we approached experts capable of positioning citizen science in the larger field of Open Science and/or reflecting on citizen science under ethical perspectives. We were looking for experts on Open Science and on RE&I, who are not focussing on citizen science alone. The European Commission names citizen science, respectively the engagement with citizens, consumers, and end-users, as one of the pillars of Open Science (European Commission, 2019). Hence, we expected that experts on Open Science could provide a broader perspective on citizen science issues than those focussing on some citizen science activities only. In the past few years ethics has become a topic in research on citizen science. For instance, in 2019 Citizen Science: Theory and Practice, the scientific journal of the Citizen Science Association, released a special issue on ethical issues in citizen science,[65] and a few scientific publications discuss research integrity issues in citizen science (e.g., Resnik et al., 2015; Rasmussen 2019; Tauginienė, L. et al., 2021; Oberle, 2019).

As experts on Open Science, we interviewed:

- Dr Sara Decoster, KU Leuven, Libraries Central Services (Belgium)
- Prof. Fa-ti Fan, Binghampton University, History Department (USA)
- Glenn Hampson, Science Communication Institute and Open Scholarship Initiative, Programme Director (USA)
- Alexander Refsum Jensenius, University of Oslo, Centre for Interdisciplinary Studies in Rhythm, Time and Motion, Professor of music technology (Norway)
- Dr Victoria Moody, Joint Information Systems Committee, Director of research and innovation sector strategy (UK)
- Prof. Yasuhiro Murayama, National Institute of Information and Communications Technology, Research Executive Director (Japan)
- Dr Madeleine Pownall, University of Leeds, School of Psychology, Lecturer (UK)

[65] https://theoryandpractice.citizenscienceassociation.org/collections/special/ethical-issues-in-citizen-science/

As experts on research ethics and integrity we interviewed:

- Dr Lidia Borrell-Damián, Science Europe, Secretary General (Belgium)
- Dr Lyn Horn, University of Cape Town, Director of the Office of Research Integrity (South Africa)
- Prof Rebecca Lave, Indiana University Bloomington, Department of Geography (USA)
- Prof Aleta Quinn, University of Idaho, Department of Politics and Philosophy (USA)
- Dr Nerea Turreira Garcia, University of Copenhagen, Department of Food and Resource Economics (Denmark)

4.2 Results

The expert interviews have demonstrated again how strongly conceptualisations of citizen science depend on context and framing. Also, cultural contexts should not be underestimated: Someone who speaks of citizen science in the USA may mean something quite different from someone in Japan or Germany. The historian of science **Fa-ti Fan** pointed out in the interview that citizen science is a socio-political term, i.e., it is a term that not only has scientific connotations but also, as the term "citizen" shows, political connotations, possibly ones that those who use the term are not sufficiently aware of. **Nerea Turreira-Garcia**, who carried out participatory projects in the global South, told us that in the global South, the term citizen science is much less common than in the global North. There, at least in relation to environmental issues, the term participatory environmental monitoring is probably more common. We deliberately decided to interview experts from different continents, or experts who have carried out projects on different continents, which in principle fall under the European Commission's definition of citizen science. Among other things, this showed how much ideas of citizen science depend on which tasks are taken over by the state, which are handed over to civil society, how the university system is organised and how open it is, especially how good the chances are for different members of society to acquire higher education and how much it depends on a wealthy family background. **Rebecca Lave** cites an example of successful citizen science community-based research projects, e. g. on an environmental topic of a community that directly affects the community and on which the participants are involved throughout the entire project cycle: from the development of the questions to the application of the project results. In some European countries, such projects might fall under social work but not under science. Especially **Nerea Turreira-Garcia** and **Aleta Quinn** stress the tension between so-called western science on the one hand and traditional ecological knowledge and indigenous knowledge on the other, which arises in research projects of scientists with indigenous people. The challenges and ethical questions that open here for citizen science are hardly considered in the debates on citizen science. Should we call such cooperation citizen science, or would we be transferring ideas of knowledge generation that would not suit everyone involved? It is therefore not surprising that the expert interviews show again that citizen science is conceptualised quite differently, also, but not only, because the vagueness of the term allows quite different normative ideas to be linked to it. This confirms what we have already written in D1.1 about the different conceptualisations of citizen science.

Time restrictions make it impossible to talk about citizen science in all its meanings and the experts relate to those facets of CS they had already contact with or reflected previously on. That means that also the experts gave input to partially different things, and it is not easy to compare these inputs. It is also not possible to give here sufficient

place to all the aspects and reflections brought up by the experts during the interviews. The following texts are necessarily selective. While the experts confirm some issues raised in the literature, they also regard them often from new angles.

It was also important to connect citizen science with Open Science, because the terminology is blurry, and it can create misunderstandings if one expert counts something as citizen science that another expert would rather place in the more general field of Open Science. Additionally, it gives some indication if citizen science is regarded as key for some of the postulated benefits of Open Science mentioned in literature or if it is rather seen as one measure among others.

The experts we interviewed are aware of the complexity of this concept and thematized it frequently.

"*Beware of simplistic ideas*," **Fan** warns, "*the key is to know what we are trying to do for what and for whom*."

"*No single definition does justice to the term citizen science*," says **Glenn Hampson**, Programme Director of the Open Scholarship Initiative, "*the common denominator is accessibility to the extent practicable*".

However, if the term is so open that it includes science communication, research, DIY research, science education and citizen participation in research, another problem arises, which **Alexander Jensenius** points out: "Citizen science is just a building block in Open Science. It is a problem if anything can be called citizen science."

This problem is still unresolved at the European level and could be exacerbated if attempts are made to apply the term globally to all science-related activities in which non-scientists are involved in some way.

Topics related to benefits, pitfalls and caveats

Asked about the advantages and disadvantages of citizen science, the experts gave their thoughts on some potential benefits of citizen science, which, as **Fan** puts it depend on the goals and means.

Asked for pros and cons of citizen science, **Victoria Moody** gives a very optimistic view as she sees only advantages: "*Citizen science is vital to ensure science can address urgent societal challenges and it is important that there is both strategic and systemic focus in support of optimisation and innovation of citizen science in research with a core and inclusive focus on the public good*."

As a benefit for making more science possible, several experts mention data collection on a larger scale. "Participating in scientific processes by observing, gathering and processing data is a basic form of citizen science" (**Sara Decoster**).

Yasuhiro Murayama points out that citizens bring additional expertise to a project. „Scientists may get new findings from learning of the views of citizens." Social psychologist **Madeleine Pownall** expresses similar views: "*Involving citizens can lead to additional insights and ideas.*" And she adds: "*It can improve the robustness and thoughtfulness of the research process itself - and can reduce questionable research practices.*" „*Researchers appreciate the social value*", says **Sara Decoster**.

Aleta Quinn reports that direct experience with animals and environmental issues can be transformative, for example when someone holds a snake for the first time in their life and understands how its muscles move.

In literature it is often emphasised by policymakers and researchers alike that citizen science contributes to a better understanding of science or an increase of "*scientific literacy*" – an unspecific term that leaves much room for interpretation. In our expert interviews reflections on the potential for non-academic participants to learn about science come up as well. However, it is necessary to differentiate between different uses of the term citizen science. For example, considering crowdsourcing projects in the natural sciences, **Rebecca Lave** is sceptical that much science education happens in them.

Sara Decoster puts what science education should be about as following:

> *"I think people need to realize that an important aspect of science is about doubt and uncertainty, which are in fact essential components of science, as demonstrated by epistemologists like Popper & Kuhn. The idea that something is true only until the contrary has been proven. But now citizens are asking scientists to give clear answers, to tell them the truth and are not always aware that the truth might not exist. Or that truth of today is not the truth of tomorrow."*

Potential positive social impact and support of vulnerable groups is important for several experts. **Lidia Borrell-Damían** says that universities can get involved in disadvantaged neighbourhoods to work with residents to improve life in these neighbourhoods. **Aleta Quinn** describes projects for teenagers who are interested in a science topic "*but maybe can't afford to go to college*". Such examples coming up in the expert interviews indicate that the question of a social benefit of citizen science might more strongly depend on regional education and social systems.

Lyn Horn; Director of the Research Integrity Office at the University of Cape Town, points out a potential benefit of grassroot citizen science: It can provide counter expertise and open access to data powerful people with hidden agendas try to hide. However, she mentions a potential pitfall: That activists and scientists should be careful not to overstep their field of expertise. And **Glenn Hampson** warns of "potential misappropriate use of findings to support other agendas". **Nerea Turreira-Garcia** says that "*understanding the agenda behind a Citizen Science project may serve, understand whose interests it serves and how 'inclusive', 'reciprocal' and 'democratic' the project is*" is crucial.

"It is not obvious to involve citizens in every aspect of science", says **Sara Decoster**. "*Citizen science is more complex than it seems*", she adds. Particular skills, especially communication skills (especially in collaboration with vulnerable groups), are required. "*It does not work for all kinds of research.*"

Or, as **Glenn Hampson** puts it: "*Citizen science is not realistic for all research*". It is important to understand what can be achieved with Open Science practices and what not, he stresses. Accordingly, those who promote citizen science should be careful with raising expectations of what can be achieved with it. Among others, **Lidia Borrell-Damían** stresses the importance of "*expectation management*" in citizen science,

Aleta Quinn sees another danger if the view among random people is promoted "to portray themselves as scientists and start thinking they are allowed to do things that other people are not allowed to do".

Another aspect to be considered when organizing citizen science activities is time: Relationship building, setting goals, setting up project structures, governance and monitoring mechanisms takes a lot of time, says **Aleta Quinn**: "*Successful citizen science is very time consuming.*" **Sara Decoster**, **Madeleine Pownall** and **Rebecca**

Lave draw attention to this fact in a similar way. Citizen science requires a lot of time, says Decoster, and Lave and Pownall point out that it can take longer than traditional research.

If Citizen Science is funded, resources are spent that could be used for other scientific endeavours. If we involve citizens in decisions about research priorities, this may become an issue for highly specialised research that may not get funded because communication skills may be more important than others, says **Sara Decoster**.

Aleta Quinn brings attention to another possible dark side of citizen science becoming popular:

> *"I think Citizen Science sells well. In the museum community, if you're trying to get a job as a curator or even a collections manager these days, they want you to have some component of interacting with the community and they want the phrase citizen science to be on your resume. There seems to be a push in a way that it might take resources away from other activities. It might oversell the concepts of citizen science."*

In the literature we often found the narrative of citizen science being principally harmful for academic careers. It might justify an investigation how much this has changed and/or in which professional areas this is (still) true.

Ethical issues

The experts on research ethics and research integrity we interviewed mentioned several ethical issues, including such well-known ones as privacy, and inclusion barriers such as access to appropriate ICT and experience with using them. Some issues they drew attention to appear not to be discussed in citizen science communities.

According to **Lidia Borrell-Damían**, in respect to research integrity the issues in citizen science are the same as in other ways to do science: intended misconduct (e. g. making up results, falsifying or manipulating data, manipulating images and plagiarism) and questionable research practices.

Research quality in citizen science allows no more compromises than does "traditional" research, not only because of the negative impact it would have on science itself but also in terms of science education, societal benefit or building trust in science. Lowering standards for research or scientific conduct would be counterproductive. **Lidia Borrell-Damían** summarizes this by clarifying that citizen science does not mean pseudoscience or second-rate science. It engages citizens as an additional actor but does not replace the scientist. If it is not scientifically sound it would be detrimental to citizen science.

Involving citizens in research, so **Yasuhiro Murayama**, brings with it the challenge that citizens are not bound by norms of scientific disciplines. If they do not have sufficient scientific training, they might be incompletely aware of these norms and do something wrong with good intentions, e. g. to destroy animal habitats.

Such issues of unintended scientific misconduct were mentioned by several experts. **Lidia Borrell-Damían**, **Lyn Horn** and **Aleta Quinn** give examples of people acting in good faith or with the purest intentions. Potential ethical issues in science are complex, not always obvious and need some acquisition of knowledge. "*Science needs to remain science*", says Sara Decoster, "*quality assurance is necessary (but easier said than done)*."

Ethical issues may also depend on project design. *"Who decides project objectives, methods, data validation, and data use, in short: the project agenda?"* asks **Nerea Turreira-Garcia,** as *"such decisions decide about ethical issues, too, especially in participatory research activities such as participatory environmental monitoring."*

One issue that has been mentioned by experts working on participatory research is that of recognition of the citizens involved and of citizen science itself. For example, scientific journals make it difficult to adequately name citizen scientists. According to **Rebecca Lave** this applies even to relatively small projects involving 40 or 50 persons, where naming them would be a realistic option.

According to **Nerea Turreira-Garcia**, those who collect data should also receive appropriate recognition. In any dissemination effort all contributors should be acknowledged. According to **Rebecca Lave**, citizen science activities are not adequately valued in research assessment. A widely accepted form of recognition is payment. In most cases, citizen scientists work unpaid or even pay something for it. Especially **Rebecca Lave** and **Nerea Turreira-Garcia** find this problematic. Turreira-Garcia, who has conducted scientific projects in low-income countries, notes that unpaid contributions to projects led by paid scientists are not obvious. Without payment, people with few financial resources can be excluded from participation, especially when it comes to more time-consuming contributions. Rebecca Lava calls citizen scientists an unpaid labour force for scientists and demands that in principle everyone who contributes should be paid. She suggests that there should be a separate pool of money for this.

An issue that was mentioned from different perspectives – for example by **Alexander Jensenius** from an Open Science perspective and by **Nerea Turreira-Garcia** and **Rebecca Lave** from a perspective informed by transdisciplinary or participatory research - was intellectual property rights (IPR). From an Open Science perspective, IPR can become a barrier for sharing data openly. From a data sovereignty perspective (Lave, Turreira-Garcia) the issue is if data collectors have access to data that have been collected in a project they contribute to and if they can use them. Therefore, under both perspectives there is an issue of accessibility and appropriation.

The interviews raised questions on which we have hardly found any discussion in publications on ethics in citizen science so far. **Lynn Horn** drew attention to the issue of safari or parachute research: that scientists go into low-income communities, carry out their research there, and in effect take resources from the communities without these communities having anything to gain from it. **Aleta Quinn** reports something similar about the handling of traditional ecological knowledge. She calls it the *"extractive model"*: traditional ecological knowledge is seen as a reservoir of knowledge and data. According to **Nerea Turreira-Garcia** this could be avoided if citizen science activities serve science and involved communities alike by responding to the needs of the most vulnerable people. Furthermore, she touches upon unconsidered impacts such projects may have on communities. If technology is involved, she recommends considering potential future technology dependency and its impact: Does it change people's lifestyles?

In the interview, **Rebecca Lave** pointed out that scientists might miss out on something by partially outsourcing data collection to volunteers. For perhaps scientists would notice something in data collection that citizens would not. The opportunities for unplanned fortunate discoveries might be reduced.

How to mitigate ethical issues?

One suggestion that was regularly made was to prepare scientists and citizen scientists through training. Lyn Horn pointed out that one must learn to identify ethical issues adequately. **Lidia Borrell-Damían** suggested a training programme for citizen scientists; moreover, their abilities to carry out the desired activities should be tested. In addition, further training for scientists would be needed to raise awareness of what citizen science is and means. In the context of this training, scientists should also be informed about potential pitfalls. Also, **Aleta Quinn** suggests such tutorials, but at the same time she points out that this could lead to a situation where fewer people participate in citizen science and thus less data are collected due to the additional efforts required by citizen scientists. At the same time she points out that closer cooperation between scientists and citizen scientists cannot only prevent ethical issues but can also reveal ethical issues scientists are not aware of.

The use of ICT in citizen science has its pitfalls. On the one hand, poachers can access location data to find out where endangered species are, but on the other hand, there are potential barriers for participants to use these ICT. **Aleta Quinn** suggests designing biodiversity databases in such a way that poachers cannot access location data; **Nerea Turreira-Garcia** recommends making data collection as low-tech as possible and to give data collectors full ownership of their data. However, as **Rebecca Lave** remarks, data and results must be made available to volunteers in a way they can understand them.

5 Educational citizen science activities in Europe

Marinos Anastasakis & Kathy Kikis-Papadakis

5.1 Preamble

The effort on the identification of CS related educational platforms, projects and activities operating in European countries as identified by National authorities and a preliminary explorative desktop research on such activities in the countries did not result to the anticipated amount of information to allow for any level of analysis on similarities and/or differences on CS education related perceptions and activities among the European Countries.

Table 1 presents a general view on CS platforms, projects, activities, and resources identified by the subset of European Countries that responded to our call. Table 2 presents the same information that has been identified by web search for countries which did not respond to our call.

5.2 Introduction

In recent years, several associations aiming at supporting research for and engagement in CS has been established in Europe (European Citizen Science Association, ECSA), the USA (Citizen Science Association, CSA) and Australia (Australian Citizen Science Association, ACSA). Such initiatives have allowed researchers, citizens, and proponents of CS to collaborate and develop methods to collectively evaluate a project's effectiveness (Jordan et al. 2015) both through face to face as well as through digital communication (Macq & Tancoigne 2017). In addition, many special issues of scientific journals were dedicated to CS, including Frontiers in Ecology and the Environment (Henderson, 2012), Journal of Science Communication (Weitkamp, 2016), Conservation Biology (Lukyanenko et al. 2016), Biological Conservation (Ellwood et al. 2017) and Environmental Scientist (Ashcroft, 2016).

As of the 2010s, several factors acting as obstacles in the process of integrating CS in education have been identified in the literature; among the most common ones are issues related to data collection, the inclusiveness of CS and teachers' pedagogical profile. The validity and ethics of data collection constitute one of the most important issues that stem from students' participations in CS programs (Gardiner et al, 2012). For example, in some CS projects volunteers act as data collectors remotely and are rarely involved in monitoring the process (Mueller et al. 2011). Since CS educational programs aim to cultivate students' scientific skills through their active involvement in collaboration with scientists (Bonney et. al, 2009), the educational community needs to develop specific student training methodologies. These may include in-class activities (e.g., discussion, presentations), online seminars, classification guides, or instruction manuals. In addition, students should be provided opportunities to observe and model how experts act while engaged in field work.

Table 8: CS educational platforms, projects, activities, and resources operating in the national context of the countries which responded to our call.

Country	Agency	Links to platforms, projects, activities, and other resources
Belgium	Ministry of Education	Scivil platform: https://www.scivil.be/about-scivil https://www.iedereenwetenschapper.be/
Bulgaria	Ministry of Education and Science	http://www.strategy.bg/ https://ucha.se/
Estonia	Ministry of Education and Research	https://www.nurmenukk.ee/en https://puugiinfo.ee/ https://www.kirmus.ee/en
Finland	Ministry of Education and Culture	An important and well-known article on the CS ethics: https://vastuullinentiede.fi/en/doing-research/responsible-citizen-science Thematic contact points for CS: Havaintolähetti, Järvi- ja meriwikin liitännäiset, Levätilanne, Talviseurannan sivusto and Talviseuranta - talven etenemisen kansalaishavaintokampanja, Vesistökunnostusverkoston sivusto Museum of Natural History: Suomen lajitietokeskus, Vieraslajit.fi, Maastolomakkeet Finnish Wildlife Agency: Suurpetoseuranta Natural Resources Institute: Suurpetohavaintojärjestelmä Finnish Wildlife Agency: Riistakolmiot Finnish Environment Institute: Pyöriäishavainnot Natural Resources Institute: Hylkeet, Kuolleena löytynyt hylje BirdLife Finland: Tiira Natural Resources Institute: Kalahavainnot.fi Finnish Association for Nature Conservation: Ikkuna Suomen luontoon Finnish Meteorological Institute: Omat säähavainnot (IL)

Georgia	Ministry of Education, Science, Culture and Sport	https://rustaveli.org.ge/eng/konkursebi-da-programebi http://www.mes.gov.ge/content.php?id=77&lang=eng http://mes.gov.ge/content.php?id=10310&lang=eng https://www.tsu.ge/en/research/institutes_centers/dzhfchaxf0vslo7uv/ http://junior.tsu.edu.ge/en/plwhlof1eeawv5snz/ https://iliauni.edu.ge/en/siaxleebi-8/gonisdziebebi-346/isu-science-picnic-2019.page https://iliauni.edu.ge/en/iliauni/projects/mecnierebis-popularizaciis-proeqtebi
Germany	Federal Ministry of Education and Research	https://www.buergerschaffenwissen.de/en
Ireland	Department of Education	Science Foundation Ireland
Latvia	Ministry of Science and Education	https://data.gov.lv/dati/eng/dataset/citizen-science-initiatives-in-latvia
Sweden	Ministry of Education and Research	https://v-a.se/english-portal/goals-and-mission/ https://forskarfredag.se/researchers-night/mass-experiments/

Table 9: CS educational platforms, projects, activities, and resources operating in the national context of the countries which did not respond to our call.

Country	Links to platforms, projects, activities, and other resources
Bulgaria	http://www.strategy.bg/ https://ucha.se/
Croatia	https://croatianmakers.hr/en/home/
Czech Republic	https://www.ibot.cas.cz/en/about-ib/history/
Poland	https://cordis.europa.eu/project/id/824580
Romania	https://eu-citizen.science/project/98 https://scent-project.eu/scent-pilot-campaigns https://www.researchgate.net/project/Indicator-Bats-Program
Serbia	https://www.cpn.edu.rs/en/about-the-center/ http://www.bos.rs/en/news/215/2019/10/08/citizen-science-in-belgrade_-new-20-citizens-monitor-the-air-quality.html
Slovakia	National Centre for the Popularisation of Science and Technology, SCSTI Projects: http://www.enviroza.sk/ https://www.cvtisr.sk/en.html?page_id=58 SLOVAK CENTRE OF SCIENTIFIC AND TECHNICAL INFORMATION
Slovenia	www.invazivke.si https://www.tujerodne-vrste.info/en/
Spain	FUNDACIÓN IBERCIVIS (IberCivis Foundation): https://ibercivis.es/

	CIENCIA CIUDADANA EN ESPAÑA: https://ciencia-ciudadana.es/ Centro Nacional de Educación Ambiental: https://bit.ly/2NJYelX ECENEAM Reeducamar: https://bit.ly/3gjd8fo CENEAM Voluntariado y Ciencia Ciudadana sobre biodiversidad: https://bit.ly/2YMVISc NATUSFERA Adaptation of iNaturalist Obra Social "La Caixa", the National Node of Biodiversity in Spain, GBIF.ES The Institute of Marine Sciences (https://natusfera.gbif.es/) AEMET (Agencia Estatal de Meteorología): http://es.minimet.net/ ALUCIENCIANANTE – CIENCIA Y TECNOLOGÍA PARA PEQUEÑAS MENTES Saca la lengua ciencia ciudadana Zgz Oficina de ciència ciutadana de Barcelona
Ukraine	http://www.ukrbin.com/

Another issue concerns the inclusive character that CS educational activities should adopt when dealing with students. Inclusivity here refers mostly to the demographic decomposition of the student populations participating in CS and their learning styles. The literature provides guidelines for equality and inclusion of all students in the science of citizens. For example, research on colour student support in science has shown that certain pedagogical practices such as careful guidance (Pfund et al., 2016) or strong supportive social networks (Stolle-McAllister, 2011) support the continued participation of students from different groups. In addition, communication technologies and social networks are a very important way to facilitate participation and encourage youth participation (Newman et al. 2012).

Finally, a reoccurring issue in the literature is an educator's pedagogical profile. For example, teachers' self-perceptions of holding a role with great responsibilities (Fazio & Karrow, 2015), their confidence in knowledge of scientific content and scientific literacy (Jenkins et al., 2015) or in their skills for outdoor projects (Kelemen-Finan & Dedova, 2014) may prevent citizens from participating in science projects. Teacher training programs enhance expertise and are seen as an important means of overcoming barriers to school participation (Zoellick et al., 2012). Furthermore, it is important to establish collaborative relationships between teachers and the scientific community so that educational and scientific results are in balance (Kelemen-Finan et al., 2018).

5.3 Initiatives supporting the implementation of Citizen Science in formal educational settings

Among the most important attempts aiming at identifying the limitations and suggesting good practices for the implementation of CS -in and out of educational contexts- are the consensus study report by the US National Academies of Sciences, Engineering, and Medicine (National Academies of Sciences, Engineering, and Medicine, 2018) and the COST Action (CA15212) in Europe (COST, 2016).

5.2.1 National Academies of Sciences, Engineering, and Medicine

In 2018, the US National Academies of Sciences, Engineering, and Medicine was appointed to conduct a study on "how citizen science projects can be designed to better support science learning" (National Academies of Sciences, Engineering, and Medicine, 2018, p.2). According to Academies' report, formal educational spaces are one of the settings in which CS appears having a substantial potential for supporting learning. Due to the absence of design strategies *specific to CS*, the committee reviewed the literature and suggested several guiding principles and guidelines. In the report, three general ways of designing CS projects are presented: (1) design a CS project with learning outcomes that follow the constraints of formal education; (2) adapt existing CS projects to meet certain learning goals and (3) borrow specific CS practices as a way of achieving certain learning outcomes. In more concrete terms, the following evidence-based principles that are relevant across CS are provided (National Academies of Sciences, Engineering, and Medicine, 2018):

> (a) All stakeholders in CS (e.g., designers, researchers, participants) should carefully consider and address issues of equity and power throughout all phases of a project's design and implementation.
> (b) CS projects should support partnerships among scientists, education researchers and other individuals with expertise in education and designing for learning.
> (c) Designers and practitioners should intentionally design for learning by defining intended learning outcomes, identifying their audience, integrating learning outcomes into project goals, and using evidence-based strategies to reach those outcomes.
> (d) Designers should use proven practices of design, including iteration and stakeholder engagement in design.

In addition, the report provides nine well-known and ubiquitous design recommendations which can be applied effectively to CS. These are:

1. *Know the audience*: investigate participants' motivations and needs
2. *Adopt an asset-based perspective*: students' involvement in the project needs to be based on existing knowledge and experiences so that "learning by doing" can be activated
3. *Intentionally design for diversity*: follow designs that promote inclusivity
4. *Engage stakeholders in design*: follow student-centred and follow-up processes while designing a project
5. *Capitalize on the unique learning opportunities associated with CS*: develop data knowledge; highlight the authenticity of citizen scientists' experiences through real-world contexts and design for science literacy
6. *Support multiple kinds of participant engagement*: participating more regularly and frequently in short activities (e.g., data collection and reporting) has better opportunities to enhance learning than less regular participation.
7. *Encourage social interactions*: learning is a sociocultural activity, so anything that encourages interaction provides an opportunity for learning (e.g., online forums for participants, data collection in groups, personal meetings, and people to verify classifications)
8. *Build learning supports into the project*: achieving learning goals and expected results is achieved through the creation of collaborative networks with different roles, which can support learning paths. Designers should give opportunities to citizen scientists to communicate and apply what they learn; provide many examples and frequent feedback; link the project's scientific goals with its learning

goals; connect science process to science content and; emphasize the constructed nature of the project's knowledge

9. *Evaluate and refine*: good design for learning is an iterative process, and as such it is necessary to design evaluation, reflection, and revision into the design process of a CS project.

5.2.2 The COST Action

In Europe, the COST Action was established in 2016 to promote creativity, scientific literacy, and innovation through CS. Within this Action, the working group "Develop synergies with education" focussed on increasing "awareness about the possibilities of CS in education, by collating the knowledge of current practices and underscoring the meaning of CS in formal and informal education" (Lorke et. al, 2019, p.10). The group identified several challenges and produced a set of training recommendations for participants (people who take part in CS projects), facilitators (those who train or educate participants in a CS project e.g., scientists, teachers, nature guides, museum educators etc.) and designers (people who initiate and design CS projects).

In total, three clusters of needs pertaining to the above audiences were identified (Lorke et. al, 2019): core, operational and engagement needs. *Core needs* are related to the holistic and epistemological nature of the project. Questions such as 'why should I do this?' and 'why is this important?' are included here. *Operational needs* are concerned with training related to the project processes i.e., the practical and organisational aspects of a CS project. Finally, *engagement needs* are related to the personal and experiential needs of those involved in a project.

Based on the above, Lorke et. Al (2019) suggested several guidelines for fulfilling each audience's needs. For example, at the level of participants the following recommendations are provided:

1. Core needs
    a. Provide a clear definition and history of CS (participants may come with no previous experience or knowledge of what citizen science is)
    b. Deliver project goals and scientific background (discuss the project's overarching goals with participants; explain how the CS project assists in meeting these goals; provide background to the scientific topic)
    c. Relate the project to the training audience (communicate the project's particular relevance)
2. Operational needs
    a. Explain project design (carefully communicate the project's overall design)
    b. Describe and practice project protocols (include explanations of the protocol procedures and timings, in addition to the use of technical equipment if applicable)
    c. Introduce the project platform and practice its use (include an introduction and practice with the project's platform e.g., communication, dissemination, and data management mechanisms)
3. Engagement needs
    a. Ensure a meaningful and enjoyable experience
    b. Inform about the project's communication methods (between participants and between participants and the project's team)
    c. Reward and recognise contributions (opportunities to receive recognition and acknowledgement should be explained to participants)

d. Describe opportunities for wider involvement (opportunities for becoming more involved and contributing in additional ways should be explained to participants)

5.4 Examples of Citizen Science platforms, organisations, and initiatives in Europe

In this section an indicative number of CS online platforms, CS projects and initiatives implementing CS in school environments is presented. The examples provided here cover platforms, organisations and initiatives that were established or launched between 2013 and 2020. In the frame of the Activities-Dimension Grid of CS (ADG-CS) presented at D1.1, all the projects outlined in this section fall into Area 4 (School) i.e., they concern science education of students according to a broader curriculum. Almost all of them occur at a physical place (location of participation) and participation requires only the use of certain material provided to students however, when non-material resources are needed (e.g., certain knowledge) students are trained (requirements for participation). In most of the projects, large cohorts of students (at the size of a school or schools) are involved (scale of the CS project), in countries with various socio-economic indices (characteristics of country). Usually, these projects take place at national or EU level (geographic coverage). Most cases are dealing with objects that cannot be damaged or ordinary inanimate objects/non-sentient beings (e.g., measuring air pollution indices) or with wildlife flora and fauna (beings and/or objects dealt with). As a rule, funding comes from either government sources or the European Commission (funding) and projects are initiated and run by researchers and/or educators (initiators of CS, organisers: who runs the project?). Educators are usually familiar with the citizen scientists participating in a project (citizen scientists are known to) and given that such projects are initiated in educational contexts students themselves are acting as citizen scientists (partners cooperating as citizen scientists; individuals as citizen scientists). Most often, projects involve professional researchers/scientists (individuals as traditional scientists) covering scientific areas pertaining to climate change, ecology, and other disciplines in STEM (topic areas and/or disciplines). Finally, no incentives are provided to students for their participation (incentives and remunerations promised).

5.4.1 The EU-Citizen.Science platform

EU-Citizen.Science[66] is an online platform established in 2020. Its aim is to become "a Knowledge Hub, in aid of the mainstreaming of citizen science, and build on the growing impact of citizens participating in research across the full range of scientific enquiry". In total, 13 European organisations including universities, civil society organisations and museums are partners in this Horizon 2020-funded project which is coordinated by the Museum für Naturkunde in Berlin. *EU-Citizen.Science* is a unique initiative to promote CS within EU counties as it is a sustainable platform and a mutual learning space providing different tools, best practices and relevant scientific outcomes that are collected and available to different stakeholders (ranging from interested citizens to politicians and public media). At the following section, we present a selected number of resources and CS projects hosted in the platform.

[66] https://eu-citizen.science

5.4.1.1 Resources

Tree Tools for Schools[67]

A collection of interactive activities, spotting sheets and downloadable resources bring children closer to the environmental issues. These activities target especially school students, and they are designed to be implemented in classrooms and in the school environment in general.

Vigilantes del aire[68]

A didactic unit which acts as a proposal for working in the classroom, from early childhood up to secondary education, topics related to air pollution through the CS project Vigilantes del aire.

CS and Scientific Crowdsourcing: An Introduction[69]

This is a formal university course about the variety of different CS topics from theory to practice related to CS (requires registration).

Guides on CS and commons[70]

Didactic guides whose objective is to promote research projects to further understand and defend the common goods. The guides want to promote the production of original and contrasted knowledge among citizens. These guides mainly referred to high school students and promote the implementation of research projects accompanied (and not directed) by their teachers.

5.4.1.2 Projects

X-Polli:nation[71]

The *X-Polli:Nation* project shares (or 'cross-pollinates') approaches and tools among the public, the scientists, the technologists and the educators in order to support pollinators and CS practice. The project improves existing web-based technology as a proof of concept that it is possible to take successful tools and enhance their functionality, expand them in new geographic regions and within new audiences. The project develops an inspiring schools' engagement programme and evaluates the impact on people, pollinators, and society at large.

The project has been developed following the CS activities carried out by the highly successful OPAL project (led by Imperial College, London), in collaboration with several UK partners and the Maremma Natural History Museum in Italy. It has been funded by National Geographic USA, a global leader in crowdsourced CS. The partners, in their routine activities, seek to inspire, empower, and support a new generation of citizen scientists and change-makers by creating better CS learning opportunities for all ages. Students and teachers will benefit from a comprehensive education programme which interactively teaches young people about every stage of the scientific process. Students, that take part in CS, develop STEM skills including

[67] https://eu-citizen.science/resource/18

[68] https://eu-citizen.science/resource/11

[69] https://eu-citizen.science/resource/32

[70] https://eu-citizen.science/resource/15

[71] https://eu-citizen.science/project/74

intellectual curiosity, problem solving, creativity, statistics and data-driven decision making.

The Risk Picture[72]

The aim of the project is to explore which are the environments that young people in Sweden associate with risk. In *The Risk Picture*, 722 Swedish pupils helped researchers at the Risk and Crisis Research Centre (RCR) at the Mid Sweden University collecting images of environments that they are associated with risk. The project was coordinated by VA (Public & Science) as part of ForskarFredag – the Swedish events during the European Researchers' Night.

The Autumn Experiment[73]

Climate change is impacting when the growing season begins in spring and ends in autumn. Previous research has shown that climate change seems to affect different species of trees in different ways, and these changes vary from region to region. Although this is an important issue that fundamentally affects the ecosystem, little is known about how climate change affects the autumn leave's development of different tree species. Therefore, the *Autumn Experiment* was an important experiment. Over 10,000 pupils investigated more than 2,000 tree species from 378 different locations in Sweden. Based on the observations, researchers could examine the differences between various tree species and regions. The researchers also compared the pupils' reports with the observations made 100 years ago and with satellite images. From the researchers' point of view, the *Autumn Experiment* was a unique opportunity to get reports from thousands of research assistants around the whole Sweden. The *Autumn Experiment* was a collaboration between researchers at the Swedish University of Agricultural Sciences, Umeå University, Lund University and VA (Public & Science) and it was carried out as part of ForskarFredag – the Swedish events during the European Researchers' Night.

5.4.2 National Citizen Science platforms and initiatives

5.4.2.1 Austria

Österreich forscht[74] is an Austrian-based CS platform run by a group of the University of Natural Resources and Life Sciences in Vienna. It provides general information on CS and hosts more than 40 Austrian CS projects. Recently, citizen science quality criteria[75] were developed (February 2018), which will apply to new projects of the platform with immediate effect. All citizen science projects that are already on the platform have one year to fulfill all criteria. In addition, the University of Natural Resources and Applied Life Sciences has set up a citizen science page[76] listing the CS projects carried out at the university.

[72] https://eu-citizen.science/project/34

[73] https://eu-citizen.science/project/35

[74] https://www.citizen-science.at

[75] https://zenodo.org/record/1161953#.Ybo_Gi0Rpfp

[76] https://boku.ac.at/citizen-science/

5.4.2.2 The Netherlands

The Dutch platform *iedereenwetenschapper*[77] collects CS projects from different scientific fields. An example of a CS project for education included in this platform is the "Bury tea bags for the climate[78]" project. This is an accessible project, perfectly suited for nature lovers or schools that want to boost scientific research. The project is aimed at raising awareness of climate change and drawing attention to sustainable land use. With the help of citizens worldwide, researchers want the rate the degradation of organic material - and therefore the release of CO_2. With this data, researchers who study and predict global warming can then start working on better models. In 2014, 250 schools participated in Sweden and a full curriculum in English and Dutch is currently being developed.

5.4.2.3 Germany

The CS platform *Bürgerschaffenwissen*[79] hosts numerous scientific projects from Germany. Initiators of CS projects can upload them on the platform themselves, exchange experiences and cross-link; interested people can search for suitable projects by means of filters. An example of a CS project from this platform is *"Plastic Pirates - Go Europe!"*[80]. As part of this project schools and youth groups are called upon to collect plastic waste along rivers and streams, document the different types of plastic waste collected at different points in a section of a river, and thus actively support research as part of a cross-border science campaign.

5.4.2.4 Switzerland

The Citizen Science platform *Schweiz forscht*[81] offers an overview of projects on different topics such as society, climate, language, and the universe as well as information on citizen science and the national network in Switzerland. An example of a CS project for education from this platform is "*About oaks, herbivores and predators*"[82] where schoolchildren and scientists from hide false caterpillars in oaks and examine leaves to find out which predators eat the caterpillars and how the trees are defended.

5.4.2.5 Croatia

The *Croatian Makers*[83] is an extracurricular program developed by IRIM (Institute for Youth Development and Innovation). Its purpose is to empower all children in Croatia and the region to develop STEM competencies necessary for them to be equal citizens of 21st century, by providing not only equipment, but also education and other activities. The IRIM has developed a family of platforms, ranging from the most democratic to the most complex projects, such as robotics championships, advanced coding competitions and other advanced projects. A good example of these complex projects is a huge IoT collaborative project involving 100 schools,

[77] https://www.iedereenwetenschapper.be

[78] https://www.iedereenwetenschapper.be/projects/begraaf-theezakjes-voor-het-klimaat

[79] https://www.buergerschaffenwissen.de

[80] https://www.plastic-pirates.eu/de

[81] https://www.schweizforscht.ch

[82] https://www.schweiz-forscht.ch/de/tiere/item/368-ueber-eichen-pflanzenfresser-und-raeuber

[83] https://croatianmakers.hr/en/home/

participating in the simultaneous measurement of 7 ecological variables and presenting them on a public website in real time.

5.5 Citizen Science initiatives in schools across Europe

5.5.1 CleanAir@School

CleanAir@School[84] was a joint initiative between the European Network of the Heads of Environmental Protection Agencies (EPA) and the European Environment Agency (EEA). It was launched at a meeting of the EPA Network in Dublin in April 2018 and ran until early 2020. The initiative used citizen science campaigns to better understand children's exposure to a key air pollutant, nitrogen dioxide (NO_2), in the school environment across Europe. Children at participating schools learnt about air pollution and health effects, while both pupils and their parents saw how road transport affects air quality. A key question was whether, in the light of this knowledge, parents shifted away from bringing their children by car to school. Participating environmental protection agencies engaged with local communities and explained how they worked to improve air quality. To raise awareness of *CleanAir@School*, the environmental protection agencies were engaging pupils, teachers, and parents in the implementation of the project. Once the measurement campaigns were completed, the agencies explained the results and ran surveys at each school to assess changes in awareness and in the mode of transport used by parents and older pupils.

5.5.2 The Citizen Science Competence Centre

The *Citizen Science Competence Centre*[85] is a three-year project between four schools in Tallinn, Estonia and the Tallinn University. During the project, the schools received Globisens lab-discs[86], which are devices containing multiple sensors that can be used to collect data regarding different aspects of the environment. Tallinn University provides teacher training that aims to establish triple relationships (university, school, and regional stakeholders) and solve regional problems with CS methods and sensor-based technologies. In addition, CS-related learning scenarios are developed in collaboration with the teachers. There is a supportive application to promote data sharing and visualisation of data gathered by citizens[87].

5.5.3 Healthy air, Healthier children

The *Healthy air, Healthier children* project was part of Health and Environment Alliance's (HEAL) efforts to develop a CS initiative to monitor indoor and outdoor air pollutants around primary schools in six capitals of the European Union: Berlin, London, Paris, Madrid, Sofia and Warsaw. During March, April, and May 2019, 50 schools in these six cities participated in the initiative using low-cost monitoring devices to collect

[84] https://www.eea.europa.eu/themes/air/urban-air-quality/cleanair-at-school

[85] https://kodanikuteadus.wordpress.com/

[86] https://www.globisens.net

[87] https://avastusrada.ee/en

data on common air pollutants. NO_2 was monitored continuously for a period of three to four weeks and local partners visited each school to take a 20-minute measurement of the PM concentration in and around the schools and the CO_2 levels inside the classrooms. Berlin, Paris, London, and Madrid have breached limits for nitrogen dioxide (NO_2); Spain is breaching both NO_2 and PM EU air standards; and Bulgaria and Poland have been found to breach EU air quality legislation for PM by the EU Court of Justice. Given the differences in each city (location, geographical conditions, condition of the school buildings etc.) and differences in the intervals of measurement it is not possible to make comparisons between schools or cities. However, HEAL's report[88] demonstrates that ensuring clean air in school environments should be a priority for policymakers and a further monitoring should be undertaken. School environments have received less attention in both research and policymaking, which has largely focused on regulating outdoor air quality. At EU level, a comprehensive set of laws is in place to ensure good outdoor air quality and to cut emissions from the main pollution sources. The quality of indoor air is significantly affected by outside air, as well as indoor factors. People spend most of their time indoors, with children spending up to a third of their day at school, and yet no comparable framework exists for indoor environments.

5.5.4 EDU-ARCTIC: Monitoring of Meteorological and Phenological Parameters

EDU-ARCTIC[89] is an EU-funded project focused on using Arctic research as a vehicle to strengthen science education curricula across Europe. It aims to encourage students aged 13 to 20 to pursue further education in science, technology, engineering, and mathematics (STEM). In the frame of the *EDU-ARCTIC*, all the schools in Europe are invited to participate in a meteorological observation system in the schools' surroundings, to report these observations on the web-portal and have access to all the accumulated data. Schools and students become part of a larger citizens' effort to gain a holistic understanding of global environmental issues. The students may learn to act as scientific eyes and ears in the field. No special equipment is needed. Reporting of observations is made once a week in the Monitoring System through the *EDU–ARCTIC* web-portal or the accompanying mobile app. A manual and a field guide on how to conduct observations and reports are available through the web. Teachers may download reports containing gathered information and use them in the teaching of a wide variety of disciplines, including biology, chemistry, physics, and mathematics.

An application for the Monitoring System has been developed to engage students by making it more comprehensive to register the meteorology. Further, special webinars and Polarpedia (the project's own online encyclopaedia) entries are developed to strengthen the Monitoring System. The *EDU-ARCTIC* Monitoring System gathered more than 2000 reports from schools, with an average monthly number of more than 80 observations. They are freely available via the web-portal, but password access is needed to enter registrations and data.

[88] www.env-health.org/wp-content/uploads/2019/09/HEAL-Healthy-air-healthier-children_EU.pdf

[89] https://program.edu-arctic.eu/#measurements

5.5.5 The Scent Education Programme

The *Scent Education Programme*[90] is a Horizon 2020 funded program which aims at introducing 11–12-year-old school students to the importance of environmental monitoring. The programme focuses on the significant role that each individual student plays in making a difference to the environment. The programme engages students in local, national, and international environmental issues and equips them with the necessary skills to observe, monitor and act in their own environments.

The developed recourses and material are compatible with current curricula and can be implemented in schools. The series of lessons can easily be incorporated into subjects such as science and geography. Scent applies the train-the-trainer approach, which means that local teachers receive training and material that allow them to deliver the programme in their schools.

The programme is divided into three lessons empowering students to become citizen scientists. The first lesson introduces the students to relevant concepts and prepares them for the Scent Challenge. The second one sends the students out to complete the Scent Challenge, which involves the students observing and discovering their local environment. The third lesson brings them back to the classroom and lets them share and reflect on their findings.

5.6 Limitations of current approaches

As we have seen so far, the CS literature offers (albeit limited) several principles which can guide decisions for the implementation of CS activities into the educational practice. At the same time, there do exist examples of CS projects which were initiated for and carried out with students as citizen sciences in mind. Despite that, almost all the major attempts made so far for the inclusion of CS in formal educational settings are oriented towards teachers and/or scientists i.e., *individuals* who wish to enhance their students' learning, to maximise the benefits of a CS project or to solve an environmental problem; as such, all these efforts *do not involve recommendations at institutional level.*

In addition, the provided in the literature guidelines lack a *coherent* and *CS-specific framework* that can support not only the design of CS projects but also the true implementation of CS in school curricula. In our view, this is also evident in the examples we have reported here; clearly, students are invited to engage to CS activities *not as part of the official curriculum* but as a way of either enhancing *the existing curriculum* with additional or more motivating (for the students) activities, or as a way for *meeting the societal and economical demands* of our time.

Surely, the above may be interpreted in various ways: for example, one could say that CS as a practice which can potentially enhance education is still at its infancy. Given though that many have question or criticize CS's role in education (Bonney et al. 2016), part of this problématique seems to be related to the different goals that CS and (formal) education have: the first aims primarily at bringing about scientific progress whereas the latter aims mostly at supporting (formal) learning (Roche et al., 2020). Consequently, there is a need in providing a conceptual analysis of the actors and processes involved in the implementation of CS in school curricula. In our view, the limitations briefly reviewed in this chapter could be analysed and interpreted through the lens of Activity Theory (e.g., Engeström, 2000), where at least two activity systems

[90] https://scent-project.eu/learn-with-scent

with different objects, rules and division of labour are involved: the activity system of CS and that of (formal) education.

6 Overall methodology for all empirical research in WP2, WP3 and WP4

6.1 Method development

Reuma De-Groot

Our main aim is to study the landscape in which CS activities occur, and to better understand the participants' motivations and goals for participation in CS. In order to achieve this aim, we combine a data analytics approach based on computational methods of data analysis (i.e., web data mining, natural language processing and network analytics) with traditional qualitative and quantitative methods.

The interplay between analysis and analytics is one of the core aspects in the CS Track project. To acquire a better understanding of the landscape of CS, a set of descriptors has been created to describe CS projects such as social media accounts, platform names, project descriptions, among others. Through using this set of descriptors, and by collating information from several CS platforms globally, a database of CS projects (WP2) has been created within the CS Track project that aggregates key information on the characteristics of projects. As introduced in D3.1 (WP3), and updated in section 6.3, the data-driven analytics approaches operate on three levels of granularity (see section 6.3) with different profiles regarding automation and replicability. Special efforts are undertaken by WP4 to triangulate (see 6.5) the survey results to reveal further insights relating to incentives, learning gains, motivations, and ways of participation as well as research areas of the projects. Finally, a qualitative case study approach (WP2) is applied and integrated with other data sources for detecting good examples of CS activities.

6.2 Database reveals a complex overall picture of CS and the case study approach illustrates good CS examples

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We compiled a database (DB) by manually searching for existing CS projects that are mainly visible on the Web in the European region or associated countries. Once we had an initial list (which is consistently updated for the duration of the project), our goal was to have all the information from CS projects stored into the database. Our method was as follows: (1) analyse the source of the data to better understand its requirements and storage typology; (2) select the technical environment of the database (i.e. MongoBD); (3) define and analyse the database structure based on metadata standards (mainly PPSR); (4) use web scraping and data mining techniques (i.e. the development of a web crawler) for data extraction, classification, cleaning and storing; and (5), in order to ensure GDPR compliance, a data anonymisation process is being applied. More detailed information can be found in D2.1.

The CS Track DB is a valuable resource that has been created for research purposes within the CS Track project but also for the wider CS community (this will be presented

as publicly available datasets as part of T2.6). The list of CS projects and the additional information that have been gathered in the DB is an information resource that can be analysed on its own as well as serve as a useful starting point for another research. One of our main goals is to provide detailed documentation of selected CS projects. As already stated in D2.1, the collection of CS projects in our DB reveals a complex picture (e.g., the unstructured reporting by CS platforms, the lack of information for some descriptors, the projects that are too diverse) that challenges the sortition that was promised originally by drawing lots. For this reason, the consortium decided to adopt another approach for the selection of projects, using specific sampling techniques for each empirical case study (see the table below). The selection criteria of each study are different according to its own characteristics (see the last column in the table). Should the information in the database not meet the criteria, a search is made through external sources, and if new projects are discovered, the new ones are included in the database.

The following table summarises the list of our empirical case studies in relation to the areas identified in the Activities & Dimensions Grid of Citizen Science in D1.1 (Area 1. Input for research policy; Area 2. Taking part in research projects; Area 3. Development and innovation; Area 4, School projects with minors), their research question(s) and main methods used in the study.

Table 10: *Empirical studies*

Title of the empirical study	**Area (D1.1)**	**Research questions**	**Selection criteria and methods**
Very short questionnaire "VSQ"	Area 1, 2 and 4	RQ1: Response behaviour & patterns in a survey with a very short questionnaire. RQ2: What do CS project organisers know about participants in their projects? Are they confident to estimate gender, age and social situation? RQ3: How do academic disciplines ascribed to a project match academic expertise in the team of project organisers?	**Criteria:** Citizen Science project organizers were targeted without further preselection. **Methods:** Analysis of answers and partially of response behaviour.
Learning outcomes in CS project descriptions	Area 2, 1 and 4	RQ1: What are the learning outcomes from Philip's et al. mentioned in CS projects description?	**Criteria:** Initially 65 projects selected based on structured, semi-structured and unstructured data from the DB **Methods:** Content analysis with Natural Language Processing techniques
SDGs in CS	Area 3	RQ: How to automatically classify CS project descriptions for SDGs?	**Criteria:** Projects selected from various online sites based on the three types of data structures: structured, non-structured and semi-structured. Only includes projects with descriptions in English **Methods:** Content analysis with Natural Language

			Processing techniques
Educational uses of CS data	Area 4	RQ1: How can data science methods be effectively used to gain understanding of the potential that web data about CS projects have to inspire teachers in designing for science learning outcomes?	**Criteria:** Open call for participation in workshops **Methods**: Focus groups; content analysis.
Motivational factors and incentives in CS	Area 2	RQ: How can motivational factors provide useful information for design incentives in a CS project?	**Criteria:** Searching the DB using related keywords, projects that evidence specific engagement discourse in their descriptions **Methods:** Network analysis and content analysis with Natural Language Processing Techniques
Effects of crisis (management) on CS participation: a case study In addition investigation will be carried out on science leaders perceptions on/for CS	Area 1	RQ1: How did the COVID-19 pandemic affect participation in CS projects? RQ2: Was the COVID-19 pandemic perceived as a threat or as an opportunity? RQ4: How did CS projects manage the COVID-19 pandemic from a crisis management point of view? RQ5: Did the COVID-19 pandemic lead to an increase in the number of participants, the number of contributions or both?	**Criteria:** Driven by a baseline study with a set of cases selected **Methods:** These will be analysed by adopting qualitative content analysis and corpus linguistics methods. Moreover, science leaders' perceptions will be studied through questionnaires and semi-structured interviews.
Investigating the potential of citizen science to respond to emerging challenges - The case of COVID-19	Area 2	RQ: How have existing and emerging citizen science projects adapted to conduct COVID-19 related research? What are the design choices, characteristics, motivations and outcomes of such projects?	**Criteria:** Searching the DB using related keywords and the identification of project lists produced by citizen science associations and research institutes globally **Methods:** Website content analysis, interviews

It is also worth mentioning that our task relies on different approaches, and we aim to build on the synergies with other partners. Examples of this could be the alignment of analysis relating to the categorization framework presented in D1.1 (WP1); the application of web-data mining techniques derived from WP3 to feed the results back into the database (see also section 7.2); the findings obtained from the studies of learning outcomes, motivational factors (see Table above) will be triangulated with specific results from questions obtained from the WP4 survey; organisation of workshops with educators and other key stakeholders of the educational context[91] aimed to understand the connections between CS, learning and formal science in the context of WP6.

[91] https://twitter.com/cstrackproject/status/1467805012944244742

6.3 The interplay of computational methods and classical methods (WP3 methods)

H. Ulrich Hoppe

In the context of D1.2 and specifically for this section, we created an analytics approach allocated in WP3 as one ingredient that contributes to the overall empirical analyses conducted in CS Track. The aim is to integrate the results of analytics with the results gained using classical methods from social studies, such as questionnaires (see WP4) and interview data (see WP2). The methods adopted and then subsequently modified in the context of WP3 rely on data processing chains that take database entries (originating from WP2) as well as web or social media sources as input. The spectrum of methods includes network analysis techniques (especially Social Network Analysis or SNA) as well as content analytics with Explicit Semantic Modeling (ESA), Named Entity Recognition (NER), keyword extraction and search. The specific technique of Epistemic Network Analysis combines the detection and extraction of semantic units (known as "codes") with network analyses. The background and origins of these methods have been explicated in D3.1 (see this source also for specific references). As was already stated in D3.1, these methods can be grouped into three levels of granularity and scale with different characteristics and functions:

- At the macro level, input is harvested from open web spaces, particularly from the Twitter blogosphere using hashtags or keywords as filters. This is not limited to projects and related persons or activities that are already captured in the CS Track database. Macro-level analytics can, e.g., yield information about recent trends or "hot spots" of activity around certain people and projects (with the caveat that specific projects have still to be identified using certain indicators).
- At the meso level, analytics techniques will be uniformly applied to the subsets of projects found in the CS Track database. Examples of this type are the extraction of research areas from project descriptions or the calculation of proximities to SDGs. This allows for a one-by-one characterisation of selected projects in terms of content features. A possible supplemental step is conducting a comparison between projects in terms of multidisciplinarity and content-based similarity. Moreover, the meso-level functions are particularly supported by the Analytics Workbench (see D3.2).
- The micro level addresses details related to the activities within specific projects, such as the contributions to and interactions in forums or talk pages of the selected project. In the example of Chimp & See project on the Zooniverse platform, such analyses have been employed to shed light on the participation profiles and roles of different user groups in these interactions using both SNA and ENA based methods (Amarasinghe et al., 2021).

The computational analyses ("analytics") feed into the triangulation approach (see 6.5), which is allocated in WP4 of the project (see T4.4, Confirming evidence in support in WP4). The first challenge in this endeavour is the identification of overlapping units of analysis that may serve as bridges between different information spaces. It is important to note that we would not try to characterise or "profile" single participants, and this has been already stated in the premise of our approach. Individual projects are natural candidates to be considered as shared entities. We would, e.g., combine analytics results related to specific projects with findings from the survey. This requires the identification of answer sets in the survey data (WP4) that originate from a certain project of interest. As for the ingredients of analytics, this can involve data from all

levels as long as they derive from each project. As a result of content-oriented meso-level analyses, we have, e.g., seen cases of projects in which certain primary research areas - such as marine biology - were combined with specific sensor technologies. However, the more instrumental aspect of technologies may not be seen as a relevant research area for project participants in their subjective ratings. Such discrepancies are to be expected and they are not to be interpreted as "mistakes" but instead shed light on the difference between sheer content as opposed to subjective perceptions.

By using projects only as units of analysis and "bridges" for our work would limit the scope of the integration of "evidence" to a smaller size. To overcome this limitation, we can also look at conditions that characterise the types of projects instead of selecting projects by their identity. Possible conditions include the prevalence or absence of certain activities (e.g., Zooniverse projects shared already collected data with volunteers so that these contributors would not engage in data collection) or the orientation towards specific SDGs (or absence of SDG orientation as in most astronomy projects). It is plausible to expect that such conditions will make a difference in terms of motivation or satisfaction that the volunteers show in these projects.

6.4 Building models of CS activities

Ohto Sabel, Aaron Peltoniemi, Joni Lämsä & Raija Hämäläinen

Our aim is to study how CS is sanctioned and experienced, as well as to uncover what kind of knowledge and skills CS encompasses and thus develops. The essential part in understanding citizen science is the investigation of the practises, engagement, experiences, and forms of participation of the practitioners of citizen science, who take part in various phases and processes of citizen science projects. We seek to investigate whether participating in citizen science projects creates learning opportunities, the collaboration among participants CS, the sharing of knowledge of scientific processes that foster long-term engagement in citizen science projects.

Citizen science practitioners' roles, views, and practises were studied using a European-wide survey (see D4.1), which was constructed based on existing literature in CS and in collaboration with WP1 (see, D1.1). The preparation of the survey was conducted with experts from various fields, after which it was piloted with citizen science experts. The survey was translated into major European languages and widely distributed across Europe. The distribution of the survey was conducted in multiple ways: via media, by stakeholders, national and international citizen science organizations, and individual projects. In this phase, information on DB (WP2) was also exploited. A total of 1,083 citizen science practitioners participated in the survey. After closing the survey (WP4), responses were reviewed, and missing projects were added to the DB (WP2)

The data of the CS Track survey provides a rich base of knowledge for understanding the citizen science practitioners' perspectives and experiences. The survey data also serves an essential role in the methodological triangulation with other data in the project (see sections 6.2, 6.3 and 6.5).

First, statistical analyses (descriptive statistics and exploratory approaches) were conducted and are presented in D4.2. The results showed a rich scenery of the citizen science practitioners' perspectives and experiences. The results also revealed emerging trends and insights on practitioners' motivation, learning, collaboration, and participation roles. For example, citizen science practitioners were intrinsically

motivated in participating in citizen science projects when they were able to contribute to scientific research. Citizen scientists also felt that they learned the most by talking and interacting with others, searching information, and reflecting on previous knowledge.

Next, statistical models will be built to increase the understanding of the forms of participation, learning, knowledge building, and the factors that are associated with these constructs in the context of citizen science. These models will be built based on the experiences of the earlier statistical analyses (D4.2) as well as the knowledge acquired from the recent empirical studies (presented, e.g., in D1.1), while applying suitable statistical methods, e.g., logistic regression models. The factors influencing forms of participation in citizen science projects will enhance our understanding of the motivations of citizen scientists. Moreover, the factors influencing learning and knowledge construction will shed light on the effects of participation in citizen science projects. In practice, our models shall identify background factors associated with the CS activity. The first-hand results of these analyses will be presented in D4.3 and the final models will be published in peer-reviewed articles.

Altogether, the CS Track survey investigated citizen science practitioners' perspectives and experiences, and thus provides insights on their motivations, learning, and participation. The results of the survey, along with the methodological triangulation with other data sets, will support our understanding of the phenomenon of citizen science and provide evidence for further scientific elaborations and practical policy recommendations. The survey data will also be utilised to build a comprehensive description of CS as described in the following section.

6.5 Triangulation - using multiple data sources and methods to develop a comprehensive understanding of CS

Ohto Sabel, Aaron Peltoniemi, Joni Lämsä, Raija Hämäläinen & Reuma De-Groot

The process of triangulation will provide a comprehensive and accurate overview on the ongoing work in CS projects. To this end, we have worked intensively to study issues related to the CS community as mentioned above. The work done here was guided by our evolving Database, and using descriptors and analytics (WP2). In addition to new scientific knowledge, the triangulation of data (WPs 1,2,3 and 4) will enable policy recommendations (coordinated by FORTH) with respect to accreditation practises to study, monitor and support CS activities.

In triangulation, we use multiple data sources and methods to develop a holistic understanding of CS. Our aim is to increase the validity, strength, and interpretative potential of the CS Track project. We use at least two data sets to address the goals of the triangulation. For example, to develop a better understanding and to increase the validity of the question, "what kind of knowledge and skills CS encompasses and develops," the data will include the survey (WP4) and qualitative data from case studies (WP2). For other example, see 5.3, on how computational analyses feed into the triangulation approach. Finally, we methodically review the potentials and limitations of triangulating quantitative approaches. In practice, for quantitative approaches, the procedures could consist of administering survey data (WP4), computational data (WP2), and using pre-existing information from our database (WP2). This work allows us to deepen our understanding, for example, in relation to participation activities or to identify conditions that characterise the types of projects.

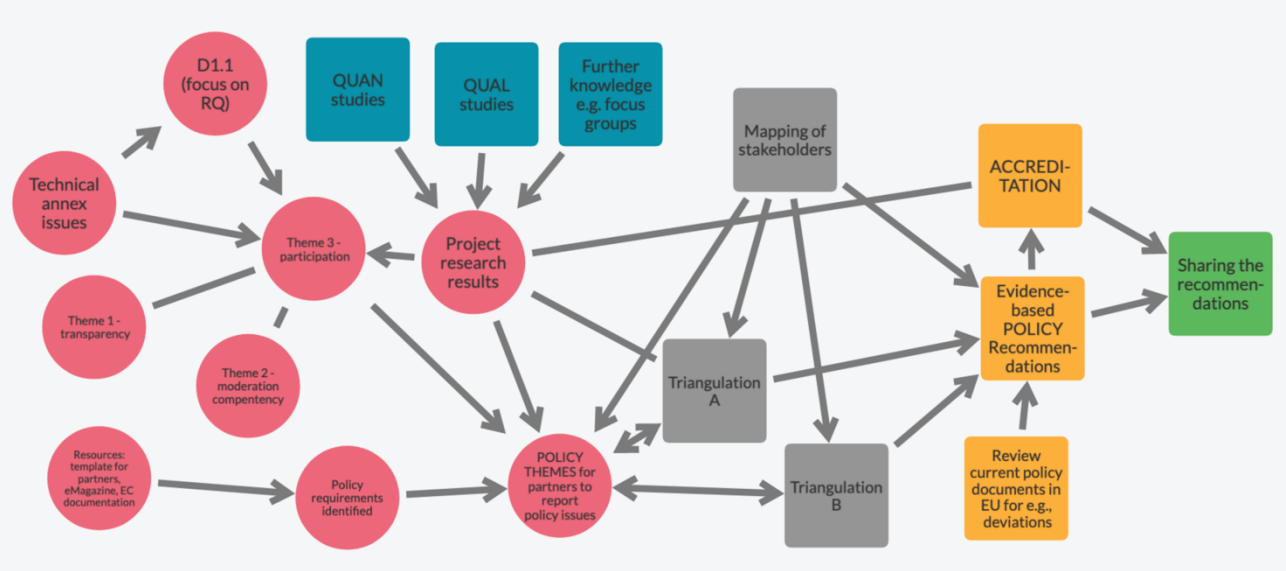

Figure. A visual representation to support the triangulation for constructing policy recommendations (FLINGA by Group 3 at the Jyväskylä Workshop 11.-12.11.2021).

Practical examples of how the triangulation would work were developed in a workshop in a hybrid format (in-person meeting took place in Jyväskylä 11.-12-11.2021). Before the workshop, all participants provided in-depth information on the concurrent research data sets for creating a basis for conceptual and empirical connections to proceed with methodological triangulation. At the workshop, in-person and remote participants collaborated via FLINGA, an online collaborative whiteboard platform, to construct a visual representation of shared research questions and data sets used to address them, forming the basis for methodological triangulation. These visual displays provide a schema for the next phase to proceed in triangulation.

In summary, the triangulation work in CS Track is built on the use of various data and analysis and analytics methods to improve the exploration and the investigation of CS's agenda to date. We intensify the triangulation work to produce new scientific knowledge on CS and offer policy recommendations. We plan to map issues which might be of interest for policies related to CS in general, and to target policymakers that stem from our current studies as well as to triangulate appropriately the different data sources to provide state-of-art recommendations. As mentioned above (6.1), items related to motivation, ways of participation, and policies are foreseen considerations. To this end, triangulation will be strongly attached to the results obtained from our survey (WP4) and its connections to the current studies taken by the consortium. In conjunction, the work in the different studies will continue to deepen our understanding regarding the selected issues mentioned above. If needed, we will implement additional qualitative analysis on selected case studies which will shed further light on, amongst other things, the ways of participation and motivation to participate in CS projects. Triangulation, despite its limitations, appropriately combines analysis and analytics to obtain the best results with work based on observing what is available. While this combination requires time, it is essential for obtaining the best results when analysing large data sources, which is also one of the targets of this project. These methodological issues can be seen also as a constraint and as a risk

taken by the consortium in paving the road for the current triangulation as well as future work carried by the consortium.

7 Computational representations, methods and operationalisation of indicators

H. Ulrich Hoppe, Nils Malzahn & Cleo Schulten

7.1 Premises

The overall conceptualisation of data models, representations and computational analytics techniques has been outlined in section 7 ("Conceptual models for computer analytics") of D1.1. The "inventory" of processing techniques (including analytics as well as user-oriented visual representations) that we draw on has been captured in D3.1. D3.1 has also introduced a schematic view on different levels of analysis (macro-meso-micro), which has been refined and further exemplified in section 6.3 of this deliverable (D1.2).

Building on the mentioned items, section 7 addresses the question how computational methods and ensuing results will be integrated with survey data and subjective judgements in the "triangulation" perspective. We start with an explanation of the assets provided by the database that has been built up in the context of WP2. This database is a dynamic resource that started with basic descriptors but is open for extension with information items generated through analytics (derived descriptors) or indicators). The following section addresses the selection and use of analytic measures and procedures to operationalise constructs that form part of specific research questions, especially regarding the integration with survey data as a prerequisite of the triangulation work. Finally, we discuss the general challenges and expectations of the triangulation endeavour.

Notably, this section and D1.2 overall are not meant to report on results of the triangulation work, which is still on-going, but to clarify the underlying ingredients, approaches and intended knowledge gains.

7.2 Database representation of basic descriptors

The database that was initially designed and built up in WP2 has projects as basic entities to be described. Access to project information was guided through the identification of platforms with collections of projects typically described in a uniform format defined by the platform. The actual extraction of information included manual, semi-automatic and automatic techniques (the latter based on web scraping approaches). D2.1 gives a comprehensive overview of the underlying design decisions, the development stages as well as the structure and content of the CS Track database. The 48 basic descriptors are attributes associated with individual projects. This initial schema can be conceived as a representation that allows for transferring and re-coding information that has been present in the web sources already. We have conceived these data as the basic descriptors. The transformation and re-coding is a necessary step to standardise the descriptions, both in structure and in the actual descriptive vocabulary. As explained in D2.1, the use of a document-based NoSQL database (MongoDB) instead of a relational DBMS facilitates the dynamic and flexible extension of the description scheme, especially to include further indicators or derived descriptors that are generated as results of applying analytics techniques to generate derived descriptors or "indicators". Technically, this means that documents may be

decorated with additional "fields" whenever a new "insight" about the content of the original "raw" document has been generated. This approach allows for evolving "higher level" descriptors of the Citizen Science activities that can be used for further processing of the data by computational and manual methods.

Since the basic database contains raw data at first, there are basically two challenges: (1) the data is rather unstructured, and (2) a lot of potential data is missing as different projects represent themselves in individual ways.

As explained in D2.1 section 3.4, the CS Track database adopts 33 of the 43 metadata fields proposed by the PPSR-Core metadata standard[92] and adds 15 additional descriptors (e.g., gender distribution, participant's profile, or website language), which were used by platforms that were crawled by the CS Track web scrapers. As the PPSR Core metadata standard is currently under development, we consider the additional metadata entries as potential candidates for an extension of this standard.

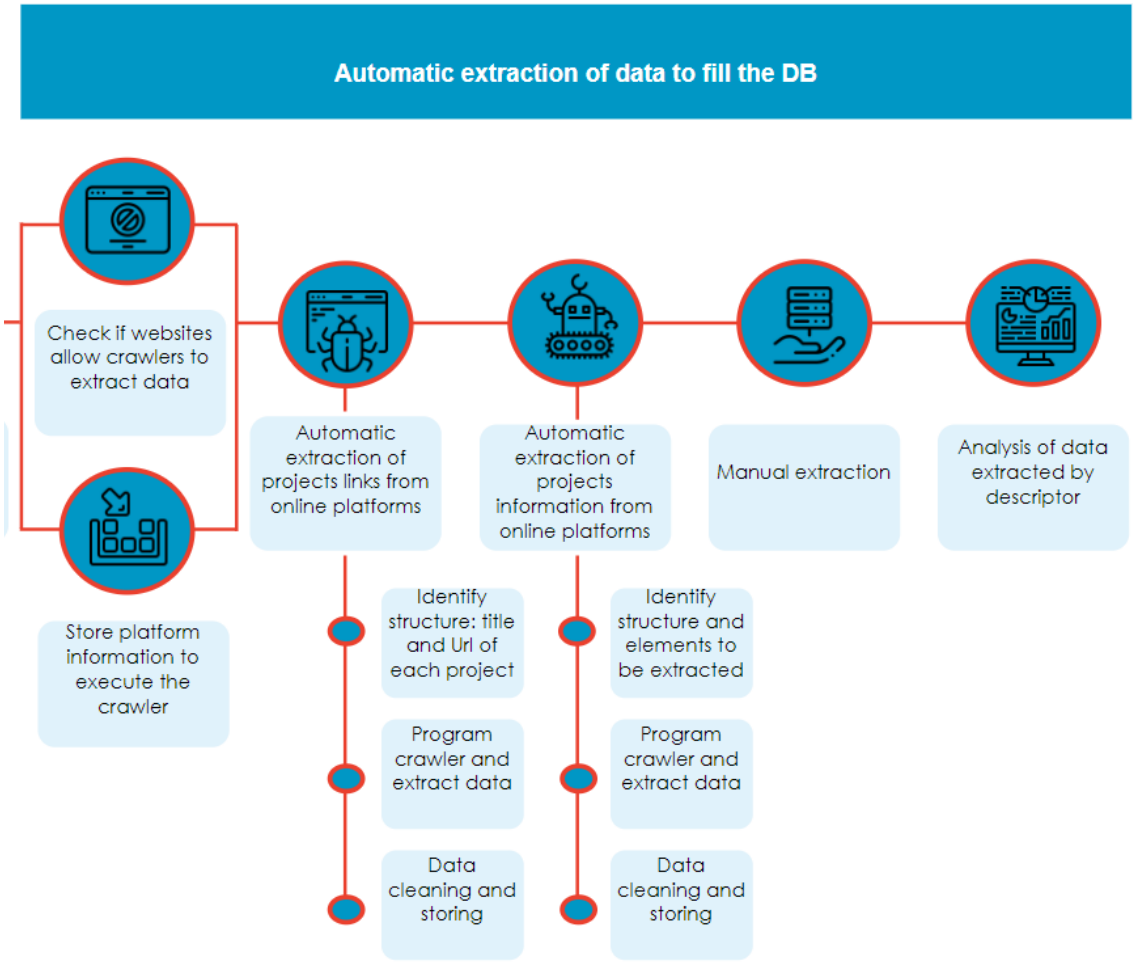

Figure 7.1: Diagram of the methodology followed to automatically extract data to fill the database (source: D2.1 section 4)

The initial data in the database is gathered by automatic crawlers (cf. Fig. 7.1) that collect the data presented on web pages of the identified CS projects. The seed of

[92] Wilson center metadata standard (2020, November 30): https://www.wilsoncenter.org/article/ppsr-core-metadata-standards

project URLs are collected from CS platforms.

As already stated in sections 5 and 6 of D2.1, there are descriptors that contain relevant information, which can be further processed to derive secondary descriptors like research areas that may be derived from the project description. For this matter, basic methods like keyword matching/extraction provide first solutions. In addition, more sophisticated methods like Named Entity Recognition (NER (Nadeau & Sekine, 2007) or machine learning based approaches (see D3.1 section 3.2 for a more detailed description) can be used to either extract new information from the crawled data or clean the data by mapping different terms to the same concept.

Figure 7.2 shows the word cloud using the field labels of the database. The size of a field label is determined by the ratio of unique entries in that field to the number of all entries for that field. This considers that some fields are more frequently filled (project name) than others (comments). Looking at the result, on the one hand some of the bigger words are to be expected: project descriptions should be unique for each project. Thus, a ratio of 1 is expected. The same is true for project name, project url and similar entries like social media addresses as they should uniquely identify a project. On the other hand, fields like **fieldOfScience**, **projectsStatus**, **projectInstitution**, **projectScientificPartners**, but also **participationTask** are not expected to be so unique as a significant number of projects in the database are collected from a "family of projects", where at least the same institutions should be mentioned more often (i. e. less unique). Lastly, some of the labels are smaller than wished for. For example, **numParticipants**, development time or **public/private_investment** should be categorized in fewer categories to enable further analyses.

Figure 7.2: Tag cloud representation of the field names in the database. The font size indicates the ratio of unique entries for a field to entries for that field in total.

This shows the already mentioned potential for cleaning, aggregating, further categorization and information extraction of and from the basic descriptors. In this sense, the collected data will be processed, and the database evolves from a

container of unstructured contents to a collection of documents containing structured and specific data following a common, but extended metadata format.

A first set of new descriptors have already been added using computational methods described in D3.1 (e.g., ESA was used to identify SDGs and assign research areas; see also D3.2). NER may also be a useful tool to identify/disambiguate persons and institutions as entities across different projects stored in the database. Furthermore, NER may be used to fill some of the gaps, e.g., by applying it to the project description.

Another pre-processing step may be the cleaning up / mapping of categorical data. Entries like **projectStatus**, **developmentTime** and **participationTasks** may be mapped to categorical data (starting, active, complete, hiatus) as proposed in the PPRS metadata standard1 from the raw data that is crawled from the web. Similarly, development time and **participationTask** may be mapped to a fixed vocabulary to enable further processing and comparison of projects or used to derive higher level indicators (see Table 7.1).

Table 11: Foreseen preprocessing of raw data to prepare basic descriptors

Basic indicator	**Derived indicator**	**Goal**	**Operationalization**
projectStatus	Reduced set of specific status' like (starting, active, complete, hiatus), etc.	Data aggregation and cleaning	Regular expressions, keywords, NLP
fieldOfScience	Research Area	Data cleaning	Keyword comparison/ synchronisation with ESA results from project description
participationTasks	Reduced set of specific tasks like "data collection", "making", "analysing" etc.	Data aggregation	NLP
projectInstitutionName projectOrganization projectPartners projectScientificPartners	Unique identifier for same institution / person	Data aggregation as pre-processing step for network analysis	NLP, keyword search
development time	Average effort for participating in project (ranges)	Data aggregation and cleansing of durations from the raw data	Regular expressions, keywords, NLP
participants profile-requirements	Specific skill set from fixed set of skills	Data aggregation to a specific set of skills to allow for higher order analysis of team formation / interdisciplinarity Also: alignment with research areas	Keyword search, NLP using thesauri

In summary, the CS Track database is a central facility for the data-driven processes around WP2 and WP3. It is embedded into a linked open data knowledge discovery datamining process (linked open data KDD; Ristoski, P. & Paulheim, 2016). Figure 7.3 shows this process. The blue boxes at the top of Fig. 7.3 describe the traditional steps of the KDD process (Fayyad, Piatetsky-Shapiro & Smyth, 1996). Ristoski & Paulheim (2016) have extended that process by linking open data into the process as a source of external knowledge (yellow boxes at the bottom). This corresponds to the inclusion

of knowledge from, e.g., DBpedia Spotlight (Medes et al. 2011) in our application of NER techniques (see D3.1 & D2.1).

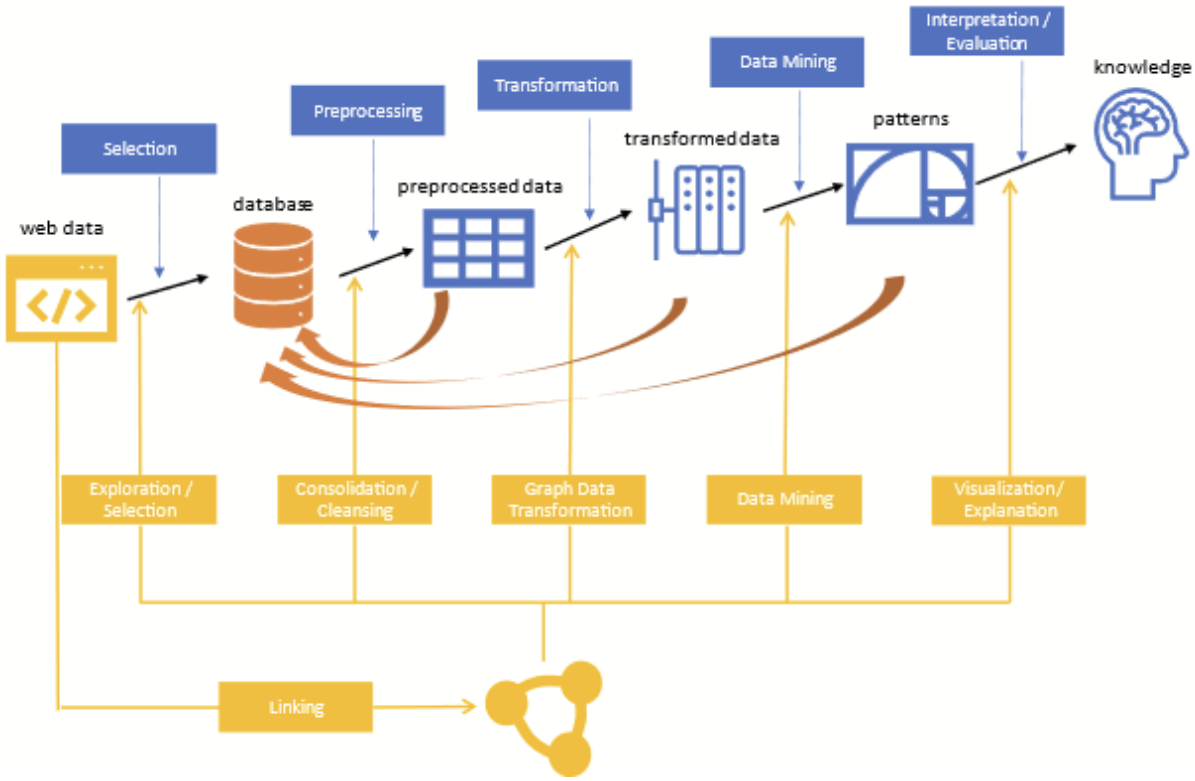

Figure 7.3: Steps of the linked open data enabled processing pipeline (adapted from Ristoski & Paulheim, 2016)

The CS Track database corresponds to the "selected" data from a database in the general KDD process (orange icon in Figure 7.3). Since we have decided to focus on those CS projects that are listed on well-known platforms (as a starting point), we have already selected the target data. As already explained, the processing results from the subsequent steps are fed back into the database. Besides re-using an already existing data storage this also enables applying more sophisticated methods in a follow-up knowledge discovery run leading not only to more precise descriptors but indicators that allow to answer research questions of CS Track.

7.3 Operationalisation of research questions using derived indicators

The research questions guiding the analyses conducted in CS Track are on the one hand rooted in the final deliverable D1.1 and on the other hand they are further extended and shaped in the triangulation activities that prevail in the second half of the project. Some questions have even already been formulated in the project proposal as contained in the Grant Agreement. This sub-section deals with the question how data-driven computational techniques can be used to operationalise certain constructs of interest in these research questions. The basic descriptors collected in the database allow for generating descriptive statistics, such as the distribution of certain project types over countries possibly using geo-mapped visualisations or timelines based on aggregated numbers.

The general idea and approach to answering the research questions is to combine information gained through (semi-)automatic processing with survey and interview data. This "fusion" has inherent requirements that relate to the input data used for analytics processing, the modelling and analytics approaches employed to compute derived variables that serve as indicators or factors in the integrated perspective. A research question is then operationalised in terms specifying these ingredients and the ensuing integrative or possibly comparative evaluation. The following Table 7.2 spells this out for several research questions. The list of questions is neither comprehensive nor is it prescriptive for the actual agenda of the triangulation. However, each of the questions addresses an issue that has already been stated as relevant before.

Table 12: Operationalisation of research questions using derived indicators

Research question *Reference to source*	**Data sources (incl. basic descriptors -> WP2)**	**Factors or indicators**	**Level / Unit of analysis**	**Operationalization (analytics results in combination with survey data)**
Do the patterns of social interaction in online CS activities change over time? Can we observe specific role-taking behaviour in the social interaction between professional scientists, volunteers, and moderators? *D1.1, chapter 4.3*	Participation / forum data	Participation patterns in online communities	Micro / Project	Social network analysis: actor-actor network Descriptive statistics: distribution (per role) of directed messages Centrality measures to quantify expertise and reputation
Role of epistemic activities (related to knowledge building) 1. How is the distribution of EAs influenced by the social roles and relations between professional scientists, volunteers, and moderators in CS online communities? 2. How does this distribution relate to the learning gains on the part of volunteers? *Grant Agreement, part B, section 1.1, page 2-3.* *Survey questions*	Annotated forum data	a) Richness of epistemic activities b) Individual learning	Micro / Project	1. Epistemic network analysis: frequency of proximal co-occurrences (edge weights in ENA diagrams) 2. Perceived learning gains (relying on data from the WP4 survey based on self-reporting)
In how far are task-enabling training activities part of the forum interactions? Who takes over the instructor role? *Grant Agreement, part B, section 1.1 Objectives, (question 4)*	Forum data with annotations, Available textual resources (Detailed project descriptions, instruction materials)	Training programs / web resources / communication patterns in online communities	Meso / Project or Set of Projects	Activity coding & counting Classification of training and learning materials (Social) network analysis Survey data

Is the self-efficacy and personal development in projects, which allow volunteers to collect and "generate" data, higher than in projects where volunteers only classify already collected data? *D1.1 – "participation issues" (p. 131)*	Project descriptions	Self-efficacy and personal development	Meso / Project or Set of Projects	Categorization of projects based on content features (e.g., relation to SDGs) Evaluation of self-efficacy and personal enrichment / development in WP4
Does a focus on primary (vs. "instrumental") research topics and reference area lead to "blind spots" in acknowledging the relevance of research (e.g., sensor technologies in environmental research)? *New, based on the analysis of the Zooniverse sample*	Project descriptions	Research areas including secondary areas (such as 'remote sensing'); quality indicators for project descriptions	Meso / Project or Set of Projects	1. Mapping of projects to research areas (with multiple assignments) 2. Self reports on research fields fromWP4 survey 3. Comparison to findings from the literature
To which extent do CS activities contribute to the "official" science in terms of scientific publications? *Recommendation from first review*	Publication databases (Google Scholar or DBLP)	(Number of) scientific publications, bibliometric assessment of CS projects	Macro / Twitter space	Bibliometrics of cs publications, aggregation per project / platform
What are trending topics in the public discussion of CS? *Grant Agreement, part B, section 1.1 Objectives, p. 4*	Twitter feeds filtered by hashtags, accounts (projects) or keywords	Number of tweets per project / topic	Macro / Twitter space	Twitter analyses, bursts and trends in topics / hashtags

A typical aspect in the integrative research perspective that we have labelled "triangulation", is that it combines and possibly contrasts objective or observational data with self-reported subjective data. Already in D1.1., we had stated that computational methods "have 'blind spots', for instance in relation to gender distribution, individual motivation, and satisfaction" (section 8, p. 134). We need to rely on interview and survey data to shed light on these factors. The integration and possibly comparison of information from different sources can be based on identified projects as "shared" units of analysis, which is limited to those projects for which both types of data (external sources + subjective reports) are provided. To expand the scope of analysis we may also formulate conditions to characterise samples of projects. Content-related analytics approaches allow for associating research areas or SDGs with projects based on semantic text processing. A recently discussed hypothesis was that projects with a strong association to SDGs (in general or specific ones) would go along with higher prevalence of altruism as a motivational factor as compared to projects with a low SDG orientation (such as astrophysics or astronomy projects). In combination with the motivational survey data, we are now able to operationalise this question. For this and other research question, it is clearly desirable to objectivate and differentiate the assignment of research areas and/or SDGs). This is supported by the Analytics Workbench in that it enables the interactive calculation of such associations based on project descriptions available in the WP2 database.

The assignment of research areas (RAs) to given projects is a central indicator of the project's disciplinary and possibly also methodological orientation. The survey data (WP4) provide subjective statements about research areas for certain projects (and with a limited number of options), also some web sources use description schemes

that include (self-assigned) research areas. To be comparable, we cannot rely on self-declared RAs but we need to standardise the descriptive vocabulary. Given the multi-/inter-disciplinary nature of most CS projects, the assignment of RAs needs to allow for multiple values. For the actual vocabulary, it is adequate to rely on bibliographic classification schemes. To standardise the descriptive vocabulary, we can rely on classification schemes used in the bibliographic realm (cf. Follett & Strezov, 2015; Kullenberg, & Kasperowski, 2016). For this purpose, we have opted for the Web of Science (WoS) classification, which has rendered comparatively good results in relation to journal classifications (Wang & Waltman, 2016). Regarding semantic extraction, we rely primarily on "Explicit Semantic Analysis" or short ESA (cf. D3.1, section 3.3.3, and Gabrilovich & Markovitch, 2009). The associations gained through ESA are grounded on text similarity with Wikipedia pages; in other words: ESA uses Wikipedia as an underlying ontology.

Obviously, RAs (or similarly SDGs) are not independent of each other but more or less related. The inter-relation of two RAs can be calculated as the ESA-similarity between the corresponding Wikipedia pages. This would not actually be empirically grounded but would be inherent in the given Wikipedia source of the reference documents as a knowledge base. An alternative approach to calculating the similarity between research areas is to look at the number of projects that have the corresponding areas assigned both in proportion to the number projects that have at least one of these areas. This calculation (using, e.g., the Jaccard measure of similarity) contains an empirical ingredient because it involves the project descriptions as mediating entities.

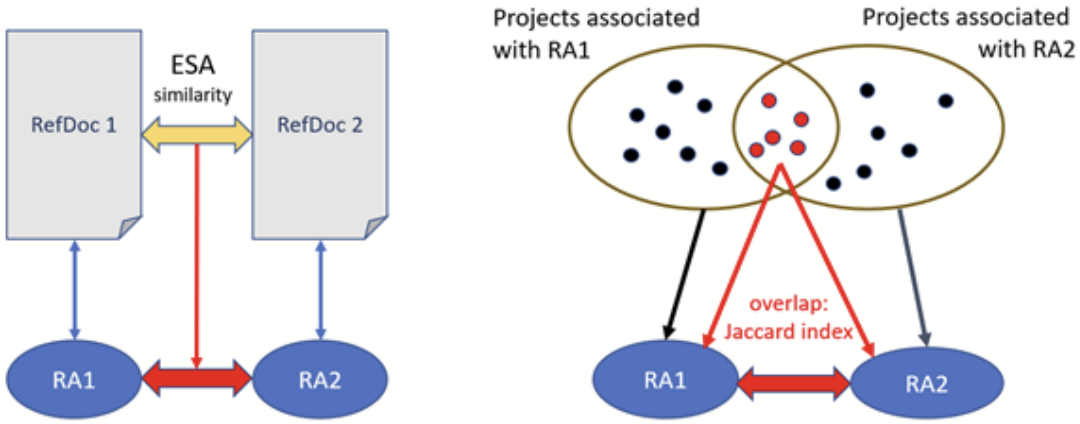

Figure 7.4: Two ways of operationalising the association between research areas RA1 and RA2 – (1) semantic similarity based on reference documents / (2) relative ratio of projects associated with both RAs in relation to all projects associated with at least one (RA1 or RA2)

Figure 7.4 illustrates the two approaches for calculating the strength of association between two research areas RA1 and RA2. Both approaches can also be applied to calculate associations between SDGs and even one SDG and one RA. Associations between RAs that were calculated based on the "semantic" method (1) should reflect then inherent proximity in the structure of disciplines and would not tell us anything specific about CS practices, whereas the association degree calculated using method (2) would indicate the prevalence of combinations in the realm of CS projects.

Similarity of "Environmental Science & Ecology" to other Research Areas
(Top 10 Ranks)

Similarity based on ESA	Similarity based on co-occurrence in projects (Jaccard Index)
1. Biodiversity & Conservation (.792)	1. Parasitology (.607)
2. Biotechnology (.742)	2. Biodiversity & Conservation (.460)
3. Anatomy (.735)	3. Zoology (.206)
4. Paleontology (.731)	4. Demography (.164)
5. Physical Geography (.730)	5. Remote Sensing (.162)
6. Zoology (0.728)	6. Veterinary Sciences (0.097)
7. Agriculture (.709)	7. Research and Experimental Medicine (.090)
8. Parasitology (.705)	8. Plant Sciences (.081)
9. Microbiology (.693)	9. Operations Research & Management (.075)
10. Geography (.690)	10. Urban Studies (.066)

Figure 7.5: Top 10 Research areas according to their ESA similarity compared to the Jaccard similarity based on co-occurrence in a sample of 2018 Zooniverse projects

We have compared the outcomes of applying both methods to the 153 RAs in the WoS classification. This results in two different similarity matrices with the dimension 153 x 153. For the "empirical" approach, we have used a pre-classified sample of 218 Zooniverse projects. In this sample, 58% of the projects had more than one RA assigned to them with 153 projects falling into the higher-level category of Life Sciences & Biomedicine (one of five in the WoS classification, again not uniquely assigned). For a comparison we use the similarities of "Environmental Science & Ecology" to other RAs, for which Figure 7.5 displays the top ten ranks for the different calculation methods (ESA based similarity compared to Jaccard similarity based on co-occurrence of RA assignments in the sample of projects). Both measures are normalized yielding values between 0 and 1, yet the Jaccard measure leads to a much sharper distinction in which values > 0.1 are already rare. The overlap between the two top-ten lists consists of only three RAs (Biodiversity & Conservation, Zoology and Parasitology). As expected, the ESA-based list reflects disciplinary proximity. Yet, the second list for which the similarity measure is mediated by the actual (empirical) co-occurrence contains research areas that reflect other types of relations to Environmental Science & Ecology such as instrumental ones (Remote Sensing) or application areas (Urban Studies, Demography). "Parasitology" would probably not be among the usual suspects at such a high rank. Indeed, 36 projects have been labelled with parasitology, yet that it also appears in rank 8 according to the semantic similarity indicates that this must have to do with characteristics of the corresponding reference document in Wikipedia.

We had argued that it is problematic to rely on the subjective assignment of RAs, especially if these assignments are unique (one RA per project). The above example shows that also automatic methods have certain systematic tendencies or biases. E.g., the semantic method will favour disciplinary proximity and rather ignore other relations (functional, instrumental) that may lead to inter-disciplinary combinations. In our planned triangulation work, we will examine how these differences influence subjective judgements. This includes a specific question already listed in Table Y, namely whether or not human raters tend to focus on semantic relations and rather ignore relations based on applications or instrumental contributions.

The characterisation of CS projects by their relation or even contribution to SDGs has been recently studied and discussed in several publications (e.g., Fraisl et al., 2020; Moczek et al., 2021). The assignment of SDGs to projects is certainly of a more secondary or derived nature as compared to the assignment of RAs. As with RAs, multiple assignments should be possible, yet the "vocabulary" is clearly predefined in terms of the list of 17 sustainable development goals declared and established by the UN (United Nations, 2017) for each of which a Wikipedia page is available as a reference document. Using the text of the UN resolution broken down to the single SDGs as a collection of reference documents allows for applying the ESA method in same way as for RAs. In the context of the CS Track project, Roldán-Álvarez et al. (2021) have analysed Twitter messages originating from CS contexts for their inter-relation with SDGs. The short messages were not directly associated with projects and did not allow for using semantically rich comparisons like ESA-similarity. This analysis was based on a machine learning approach.

Although it is technically not difficult to find (calculate) semantic associations between projects and SDGs, we believe that the approaches seen so far need to be revised: Obviously, certain areas of CS are not specifically related to SDGs, such as for instance astronomy and astrophysics, which are well established fields of CS. The project descriptions will still show a certain degree of semantic association with some SDGs, which is difficult to handle as an exclusion criterion. To better capture these cases, we plan to introduce an explicit category (non-SDG-related: 0) which can be included in (human coded) ground truth collections to train classifiers. Several publication projects dealing with these issues and challenges are under way.

7.4 Data integration and triangulation – strategies, challenges, and expectations

The data integration and triangulation work is the main activity of the second half of the CS Track project. Section 6 of this deliverable deals with the approaches and strategies used for data interaction triangulation with emphasis on computational models and algorithms. In addition to the basic descriptors, the computational methods that we have adopted and adapted can be used to generate information on project content (disciplines, methodology) on the micro and meso levels (cf. section 5.3 of this document). Participation and role assignment in the activities of volunteers can be characterised in detail through micro-level analyses of web/forum traces. However, we can only learn about motivation, satisfaction or perceived learning gains using subjective data as those that have been collected in the WP4 survey. In this sense, there is complementarity in the different data sources. However, we also have overlapping information: The survey contains responses about the research areas that subjects would see as relevant for the project(s) that they have worked with, and if we can identify these projects in the database we can compare and contrast these statements with the results of semantic information extraction.

In the triangulation perspective, what we hope for in the overlapping case is not necessarily the congruence between two results originating from the different sources. Deviations, here between subjective judgements and objective givens (in terms of external descriptions), are informative and telling as such, especially if we can identify conditions and reasons under which and why such deviations occur. This is backed by the understanding of triangulation in the perspective of social science and educational research methodologies. Mathison (1988) describes three possible outcomes from a triangulation strategy:

> *"The outcomes are not, however, an end in themselves. The researcher is left with the task of making sense of the evidence regardless of what the outcome is. So whether the data converge, are inconsistent, or are contradictory the researcher must attempt to construct explanations for the data and about the data. Following each of the examples is a possible, and hopefully plausible, explanation for the data presented. The value of triangulation lies in providing evidence--whether convergent, inconsistent, or contradictory—such that the researcher can construct good explanations of the social phenomena from which they arise."*

This understanding of triangulation has been taken up by Howe (2012), who distinguishes conjunctive and disjunctive strategies in the integration of results based on qualitative and quantitative methods. In this terminology, "conjunctive" corresponds to congruence and "disjunctive" would include complementary but also contradictory situations.

Notably, we have also adopted a method that inherently combines qualitative and quantitative research approaches. This is "Epistemic Network Analysis" or ENA, which is characterised by its inventor as "Quantitative Ethnography" (Shaffer, 2017). ENA is a kind of discourse analysis technique that relies on coding approaches typical for qualitative studies yet adds on network representations and quite sophisticated statistical techniques (similar to dimensionality reduction). We have used this method in combination with classical Social Network Analysis in micro-level study of participation and role-taking in the Chimp & See project (Amarasinghe et al., 2021).

Data integration from different sources is relatively easy if we can build on clearly identifiable projects as units of analysis. This is typical for the computational approaches that operate on the micro and macro levels; however, it is neither clear for survey answers nor for the computational macro-level analyses (based on Twitter data). The survey answers may contain references to two several projects and may also come without reference to any project. If at least two different projects (not just one being the continuation or a clear sibling of the other) are mentioned, we cannot make use of such project references. The Twitter data, such as the ones used in Roldán-Álvarez et al. (2021), have been filtered out using CS related hashtags or keywords as selection criteria. Only very few can actually be directly identified with a specific project (through mentions or based on the message originator/user being identifiable as a project). For these situations, we need strategies to avoid the identification of specific projects. One possibility is to characterise certain project types (e.g., through research areas detected by keywords) that can be compared with corresponding projects in the survey.

The workshop held November 11/12 in Jyväskylä was dedicated to intensifying and advancing the triangulation work in CS Track. Several of the issues identified and approaches formulated in the previous section 7.3 were inspired and refined by discussions during this workshop. With our efforts towards integrating data-intensive computational analyses with subjective data we are confident to be able to make a difference in the study of CS activities and practices.

↡

8 References

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9 Annex

General handout for all kinds of expert interviews in CS Track/WP1

Michael Strähle, Christine Urban & Kathy Kikis-Papadakis

1 HOW TO USE THE HANDOUTS

For each expert interview in WP1 you need 2 Handouts:

1.) The General Handout (= this document): This contains everything that is the very same for all interviews:
Procedures, methodology and templates.

2.) Specific handouts: These handouts are different by theme. Each handout contains a specific letter of invitation, the respective guideline, the conditions, durations, text length, and other specifics of the respective type of expert interview.

This document is the **general handout**. Please choose the specific handout according to the type of expert interview.

2 METHODOLOGY AND GENERAL PROCEDURES

In WP1 we do not conduct in-depth qualitative interviews, but ask for expertise on certain questions, which you find in the respective interview guideline.

We use these expert interviews – be they on geographic questions or content questions regional aspects or thematical issues - as a source, very much like as if they were literature or online resources. This means that we make the best effort not to subject expert interviews to any forms of interpretation or search for any hidden meanings.

Using the guideline
All experts receive a guideline before an interview takes place combined with the information how detailed we will want them to answer. This is connected to conditions for and length of the interview (duration, max. words for summary). The expert has occasion to reflect on the issues listed there and is not taken by surprise.

Conditions and length
The conditions depend on the interview type. Some open questions might need more time and for that case remuneration could be considered. For interviews covering regional gaps no financial remuneration is available. (See specific handout)

Social setting: Let expert decide on his/her preference
Any mixture of written and oral communication is possible. Because we do not research the expert, there is no need to standardize the interview settings. If the expert does not utter any preferences, the optimal setting depends on the intuition of those conducting the interview. Most important is that the expert is relaxed and can concentrate on elaborating on the issues of interest.

Documentation
To be sure to get their expertise, and not spontaneous feedback, and to exclude any communication errors, which always occur, experts receive not a transcript but a written summary

of what they said to the issues in the interview guideline. The expert concerned can accept it as it is, correct, rewrite or retract parts of the summary.

Consented summaries will be used an official source
Because experts are officially named as a source, we need written confirmation from them that we can use their summarized expertise in reports and publications. We need a signed agreement that they allow as to do so with the final version. We will confirm that they will indeed be fully named as an expert in all publications, papers, etc. in which we use their input, and if we quote literally from the summary, they will be cited by name.

Interviewer behaviour
All interviewers in CS Track have sufficient expertise to conduct expert interviews. For readers outside the CS Track consortium, we make summaries.

In all communication with the expert interviewers:
- Never give any opinion of their own concerning CS Track or related issues until they have a signed summary.
- Explain that the restrained communication of the interviewer serves to avoid influence.
- Signal all the time that positive, negative, neutral expert opinions on the discussed CS issues are equally welcome.
- Do nothing that creates the impression that a favoured expertise will give experts better chances to join any CS community.
- Respect time and effort of the experts by using it economically.

Procedure
Send out invitation letter, contact by phone, if no answer

➔ Explain purpose, length, and conditions
➔ Send guideline together with a signed confirmation how we will use the summary
➔ Let expert decide on setting
➔ Get data protection consent Declaration of Consent on data protection from expert
➔ Conduct interview
➔ Agree on expert summary and have it signed
➔ In some cases, a remuneration or a little surprise present has to be organized.

3 TEMPLATES

For guidelines and invitation letters, please see the specific handouts for expert interviews!

3.1 Declaration of Consent data processing

3.2 Confirmation of summary

3.3 Confirmation that expert will be named

3.1 Declaration of Consent (DoC) to the collection and processing of personal data

If the expert agrees to be interviewed, please also ask her/him to sign a Declaration of Consent (DoC) to the collection and processing of personal data. This is required by the General Data Protection Regulation. If you do not have a DoC at hand, you may use the one below.

Research project: Expanding our knowledge on Citizen Science through analytics and analysis (CS-Track)
Funding: European Commission, Horizon 2020, Grant Agreement ID: 872522
Interviewers: <INSERT YOUR NAME(S) **AND THE NAME OF YOUR ORGANIZATION>**

Pursuant to Article 6 para. 1 GDPR we collect and process the following personal data: Name, gender, affiliation, specialist field, phone number, email address.

You agree to participate in one or more interviews within the framework of the research project mentioned above. You also agree to be contacted for related research projects in the future. For this purpose, your contact data will remain stored beyond the end of the research project. Furthermore, you agree that we may transfer the above-mentioned personal data to CS Track consortium partners and the Project Officer responsible for the project at the Research Executive Agency of the European Commission upon their request. Participation in the interview is voluntary. You may at any time cancel an interview, refuse further interviews, and withdraw your consent to a recording or transcript of the interview without incurring any disadvantages.

The interviews are conducted in person, in writing or via online meeting and are recorded as far as possible (transcript and/or recording) and then summarized by researchers at <**INSERT THE NAME OF YOUR ORGANIZATION>**. The summary will be made available to you for review for one week and, if necessary, extensions/modifications. By returning the (edited) document, you confirm that we may use this document officially and publicly under your name and publish it in whole or in part in freely accessible (open access) publications such as papers in scientific journals and research reports. You will be named and seen as an expert by the publication. Personal contact information is stored separately from interview data and inaccessible to third parties (encryption of the file with the contact data, password-protected computer).

Within the framework of the legal requirements, you are entitled to claim from <**INSERT THE NAME OF YOUR ORGANIZATION>**:

- Confirmation whether personal data concerning you are processed by us,
- Information on these data and the purposes of the processing
- Correction, if these data are incorrect,
- Deletion, if there is no justification for the processing and no obligation to keep (any longer),
- Limitation of processing in special cases determined by law, and
- Transmission of your personal data - if you have provided them - to you or a third party in a common and machine-readable format.

Pursuant to Article 77 GDPR, you also have the right to complain to the <**INSERT YOUR COUNTRY>** data protection authority.
Your Declaration of Consent can be withdrawn by sending a message to **<INSERT AN E-MAIL ADDRESS TO WHICH THE MESSAGE CAN BE SENT>**, with the consequence that, in

accordance with your declaration of withdrawal, the processing of your personal data by <**INSERT THE NAME OF YOUR ORGANIZATION>** will become inadmissible for the future. However, this does not affect the legality of the processing of your data that has taken place based on your consent until the revocation.

Your personal data will not be processed for the purpose of automated decision making (including profiling) pursuant to Article 22 para. 1 and para. 4 GDPR.

This Declaration of Consent will be kept in a separate folder in a place accessible only to authorized researchers at <**INSERT THE NAME OF YOUR ORGANIZATION>**. This is only to enable them to prove that you consent to the collection and processing of the data.

A written summary of the content of the research project and the research process was handed out before the interview. You confirm this with your signature below.

Name (capital letters):
Affiliation:
Email: Date, signature:

3.2 Confirmation of the final version of the interview summary

Name of expert
Name of interviewer

Date of interview
Used guideline

<INSERT Final version of the interview summary>

Signatures

3.3 Confirmation of naming the expert as a source if the interview is used

I confirm that ……. will indeed be fully named and seen as an Expert in CS-Track in all publications, papers, reports etc. in which we use her/his input, and if we quote literally from the consented summary, s/he will be cited by name.

<Signed by interviewer and responsible institute>

Specific handout for regional expert interviews in CS Track/WP1

Michael Strähle, Christine Urban & Kathy Kikis-Papadakis

1 HOW TO USE THE HANDOUTS

For each expert interview in WP1 you need **2 handouts**:

1.) **General handout**: This is the same for all WP1 interviews. There you find methodologies and procedures and contains everything that is the very same for all interviews: Procedures, methodology and templates, and templates like the Confirmation of the final version of the interview summary, Confirmation of naming the expert as a source if the interview is used, Declaration of Consent data processing.

2.) **Specific handouts**: These are different by theme. There you find the specific letter of invitation, the respective guideline, the conditions for the experts, duration and text length of the summary of the expert interview, and other issues that are valid only for the respective type of expert interview.

This document is a **specific handout**. Before you continue, please read the general handout.

2 SPECIFICS OF THIS TYPE OF EXPERT INTERVIEWS

Information searched
These expert interviews complement extensive online research in WP1. This research aimed at finding policy papers, platforms listing projects and funding schemes in different regions.

Some important geographical gaps could not be covered: Although the language competence in the consortium is enormous, it was not possible to extend research to all languages. For these reasons, some important blind spots are investigated with the help of experts.

Experts for this type of interview
Ideally, we want experts who deal or have dealt with CS in their country, but not exclusively with CS. If they depend too much on CS projects, they may exaggerate its weight in the respective country. We are looking for persons with broader expertise, they should also know how CS is embedded in education and/or science policy. Within the EU, knowledge on Open Science in general is desirable.

Member States and Associated countries vs. all other countries

There are **2 slightly different interview guidelines**:

Version 1 is targeted at experts from EU Member States and Associated Countries. It puts CS into the context of Open Science (OS). The European Commission considers CS as a dimension of OS in general. All Member States have developed OS policies and named National Contact Points on OS. However, they can decide how they implement OS. We expect differences in considering CS.

Version 2 is targeted at experts from beyond the EU and Associated Countries. It does not explicitly put CS into the context of OS since we do not know if there is such a context in these countries.

Length & conditions

- **Length of the summary**: Between 200 and 1000 words
- **Duration:** Short, but expert should at least dedicate 1-2 hours
- **Remuneration**: No remuneration, only surprise present after interview

3 TEMPLATES

3.1 Interview guideline 1: Regional experts in EU Member States and Associated Countries

Under the label Open Science (OS) the European Commission monitors three trends:

- open access to publications,
- open access to research data, and
- open collaboration, i.e., open code/hardware policies, open peer review, citizen science projects, and public engagement in science policy.

(See https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science/open-science-monitor_en)
Other aspects of OS are Open Research Infrastructures, Open Educational Resources, Open Evaluation, and Open Methods.
In the Commission's own words, OS is an ongoing transition in how research is performed and how knowledge is shared.
The European Commission uses "Citizen Science" as an umbrella term for activities that "range from raising public knowledge about science, encouraging citizens to participate in the scientific process by observing, gathering and processing data, right up to setting scientific agenda and co-designing and implementing science-related policies". This includes science education for adults and minors and citizen participation in scientific research projects and even decision-making in science policy.

General questions on Open Science:

- How is the situation in respect to Open Science in your country in general?
- What are the areas and aspects of OS your government focuses on?
- If OS in general is promoted in your area/country, who promotes it?

Questions on CS specifically:

- Which activities to engage citizens in science take place in your country? (What comes first to your mind?)
- Is the following included?
  - raising public knowledge about science (includes science education for adults and minors)
  - participate in the scientific process by observing, gathering, and processing data
  - setting scientific agenda and/or co-designing and implementing science-related policies.
- If these activities take place in your country/region, how are they called?
- If CS specifically is promoted in your country, who promotes it?
- How would you describe these activities in your country?
- Are there CS associations, CS platforms or other information services on CS? If so, please specify them
  If they name some, we can do research on who operates them.
- Are there national or regional policy papers on OS in general? Are there policy papers specifically on CS?
- Is there funding for CS projects? If yes, who funds CS projects in which area?
- Are there discussions on public engagement in scientific research and science policy in your country?
  - If there are discussions, what positive aspects are put forward and by whom?
  - If there are discussions, what negative aspects are put forward and by whom?
- What do you think as an expert about Open Science in general and Citizen Science

specifically?

3.2 Interview guideline 2: Regional experts in other countries

According to the European Commission "Open Science is a system change allowing for better science through open and collaborative ways of producing and sharing knowledge and data, as early as possible in the research process, and for communicating and sharing results. This new approach affects research institutions and science practices by bringing about new ways of funding, evaluating, and rewarding researchers."[93]

Under the label Open Science (OS) the European Commission monitors three trends:

- open access to publications,
- open access to research data, and
- open collaboration, i.e., open code/hardware policies, open peer review, citizen science projects, and public engagement in science policy.

(See https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science/open-science-monitor_en)
Other aspects of OS are Open Research Infrastructures, Open Educational Resources, Open Evaluation, and Open Methods.
In the Commission's own words, OS is an ongoing transition in how research is performed and how knowledge is shared.
The European Commission uses "Citizen Science" as an umbrella term for activities that "range from raising public knowledge about science, encouraging citizens to participate in the scientific process by observing, gathering and processing data, right up to setting scientific agenda and co-designing and implementing science-related policies" (Science with and for Society Work Programme 2018-2020, p.30). This includes science education for adults and minors and citizen participation in scientific research projects and even decision-making in science policy.

General questions on Open Science:

- Is there a similar policy in your country? If so, how is the situation in respect to this in your country in general?
- If there are any, what are the areas and aspects of open knowledge sharing your government focuses on?
- If OS, respectively open knowledge sharing, in general is promoted in your area/country, who promotes it?

Questions on CS specifically:

- Which activities to engage citizens in science take place in your country? (What comes first to your mind?)
- Is the following included?
  - raising public knowledge about science (includes science education for adults and minors)
  - participate in the scientific process by observing, gathering, and processing data
  - setting scientific agenda and/or co-designing and implementing science-related policies.
- If these activities take place in your country/region, how are they called?
- If CS specifically is promoted in your country, who promotes it?
- How would you describe these activities in your country?
- Are there CS associations, CS platforms or other information services on CS? If so, please specify them
  If they name some, we can do research on who operates them.
- Are there national or regional policy papers on OS in general? Are there policy papers

[93] Factsheet on Open Science, https://ec.europa.eu/info/sites/info/files/research_and_innovation/knowledge_publications_tools_and_data/documents/ec_rtd_factsheet-open-science_2019.pdf

specifically on CS?
- Is there funding for CS projects? If yes, who funds CS projects in which area?
- Are there discussions on public engagement in scientific research and science policy in your country?
    - If there are discussions, what positive aspects are put forward and by whom?
    - If there are discussions, what negative aspects are put forward and by whom?
- What do you think as an expert about Open Science in general and Citizen Science specifically?

3.3 Invitation letter

Dear ....(name of expert)

My name is <xyz> and I am a Collaborating Researcher at the Foundation for Research and Technology-Hellas in Crete, Greece. I am working on a Horizon 2020 / Science project with and for Society Programme, called CS-track: Investigating Citizen Science.

A few words about CS Track:

CS Track is a project focused on broadening our knowledge about Citizen Science by investigating Citizen Science activities and formulating knowledge-based policy recommendations to maximize the potential benefit and minimize possible caveats of Citizen Science activities on individual citizens, organizations, and society at large. (Further information is available at https://cstrack.eu/.)

Among others, we will seek this increased knowledge by "investigating" which Open Science activities we find in different geographic regions what part Citizen Science plays there. We have collected data on CS projects in the web but hope for your input to get a fuller picture of the issue in <COUNTRY xx>.

Moreover, it will put CS in Member States and Associated Countries into global and historical contexts. The interviews can be conducted on Skype/Zoom, phone, or email.

Experts will be named in reports and publications and be asked to confirm summaries of the interviews by email.

In the frame of this project, I am contacting you as you are one of the main Open Science Experts in (.name of the country). To this effect, I will appreciate it if you were to inform me of your interest to participate in a future interview as an OS Expert in the CS Track project. Your contribution is more than important for the project's progress.

Kind regards,

<Your name>

Expert interviews: Questions for Open Science experts

Michael Strähle & Christine Urban, 25. 11. 2021

Under the label Open Science (OS) the European Commission monitors three trends:

- open access to publications,
- open access to research data, and
- open collaboration, i.e., open code/hardware policies, open peer review, citizen science projects, and public engagement in science policy.

(See https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science/open-science-monitor_en)

Questions on Open Science:

- Are or were there Open Science policies or specific programmes at your university or academic organisation?
- Are there any positive/negative experiences with specific areas of OS? If yes, since when and which?
- Has there been a shift of focus over time? If yes, which and why?
- Which areas of Open Science do you find promising, which do you find unpromising for the future?

Questions on CS specifically:

- How would you define or describe Citizen Science?
- Which of the following activities would you call Citizen Science?
    - Raising public knowledge about science (includes science education for adults and minors)
    - Participating in scientific processes, e.g., by observing, gathering, and processing data
    - DIY research & development
    - Setting scientific agenda and/or co-designing and implementing science-related policies.
- What are the pros and cons of the above forms of Citizen Science in your mind?
- Is there positive/negative experience with CS at your university or academic organisation?
    - Raising public knowledge about science (includes science education for adults and minors)
    - Participating in scientific processes by observing, gathering, and processing data
    - Setting scientific agenda and/or co-designing and implementing science-related policies.
- What do you think as an expert about Open Science in general and Citizen Science specifically?

CS Track has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 872522.

Expert interview: Questions on ethical and integrity issues in citizen science

Michael Strähle & Christine Urban, 25. 11. 2021

Under the label Open Science (OS) the European Commission monitors three trends:

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- open collaboration, i.e., open code/hardware policies, open peer review, citizen science projects, and public engagement in science policy.

(See https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science/open-science-monitor_en)

Other aspects of OS are Open Research Infrastructures, Open Educational Resources, Open Evaluation, and Open Methods.

In the Commission's own words, OS is an ongoing transition in how research is performed and how knowledge is shared.

The European Commission uses "Citizen Science" as an umbrella term for activities that "range from raising public knowledge about science, encouraging citizens to participate in the scientific process by observing, gathering and processing data, right up to setting scientific agenda and co-designing and implementing science-related policies". This includes science education for adults and minors and citizen participation in scientific research projects and even decision-making in science policy.

Questions

- Have you worked on research ethics, research integrity or ethical guidelines related to one or more of the following areas?
  - Raising public knowledge about science (includes science education for adults and minors)
  - Participating in the scientific process by observing, gathering, and processing data
  - DIY research & development
  - Setting scientific agenda and/or co-designing and implementing science-related policies
  - Other activities in the context of cooperation with NPOs or individual laypersons, science education, two-way science communication, user involvement and/or participatory approaches targeting research policies
- Do you see ethical issues, and if yes, which ones?
- Can – some of them – be mitigated or even solved, and if yes, how?
- What do you think as an expert about Open Science in general and Citizen Science specifically?

CS Track has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 872522.