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**Analyses on the role of non-state actors for the implementation of
Sustainable Development Goals**

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Abstract

The 2030 Agenda for Sustainable Development, adopted by United Nations (UN) Member States in September 2015, aims to solve world sensitive sustainability issues through 17 Sustainable Development Goals (SDGs) as focus areas. The implementation of the SDGs will depend mainly on the voluntary commitments of member states, although an integrated approach between countries, disciplines and actors is needed.

This study, through comprehensive analyses, considers three important elements of the 2030 Agenda: 1) “Partnerships for the Goals”; The 2030 Agenda, stresses the importance of alliances and partnerships, as explicitly expressed in Goal 17. The collaborations of multi-stakeholder networks can be beneficial, but evaluation of their impact remains a challenge. Analyses in Chapter 2, based on the contribution of Regional Centres of Expertise for the implementation of the 2030 Agenda, explore these collaborations in local, national and international scale. 2) “Indivisibility” of the 2030 Agenda, and the interconnection between the Goals; it is widely accepted that the 17 SDGs are strongly interrelated and context dependent. The implications of Target 4.7 on the 17 SDGs, in the specific context, are addressed in Chapter 3. Strongest connections amongst thematic sustainability issues are identified in order to maximise synergies and to minimise negative influences. It helps to create a ground for common indicators that can contribute simultaneously to a set of Goals, and to the 2030 Agenda as a whole. 3) The “All-inclusiveness” aspect of the 2030 Agenda where every contribution is valid. Several “collaboration channels” for Citizen Science and the Agenda 2030, such as through organized networks representations in partnerships for the goals; contribution to each of the SDGs individually; involvement in the policy cycles; and education and data provision, are explored in Chapter 4. Challenges, critical aspects and a framework of interactions from the top-down and bottom-up perspective are discussed in order to encourage a broader and more effective engagement.

This study has analysed the role of diverse non-state actors and disciplines in the process of achieving the 17 SDGs. It gives an overview to what extent they are involved, based on current evidence and on clear contextual settings, and of the specific difficulties, challenges and opportunities. Findings identify considerable efforts by these actors in aligning their work with the 2030 Agenda, but additional efforts and resources are needed. Financial issues and governance bottlenecks, uneven progress between Goals and regions, weak coordination mechanisms among stakeholders, silo approaches with the Goals etc. are considered to be the major challenges for achieving the SDGs.

The timeframe for the SDGs implementation has entered the “Decade of Action” until 2030. Apart from the member state commitments, the emphasis on “*global*”, “*local*”, and “*people*” would give importance to the involvement and increasing responsibilities of other actors, and contributions from all sources. New governance models at multi-levels, are needed to coordinate the SDGs and embrace the wide range of actors in the process. Global governance and regulating mechanisms at international level are necessary as national strategies will not be enough. Since networks and partnerships are dependent on their regional contexts and other circumstances, stronger cooperation with international organisations active in the SDGs implementation process would secure them a better position in the international arena. The study reinforces the idea that non-state actors can contribute outside their country contexts, at both local and international scale.

Zusammenfassung

Die Agenda 2030 für nachhaltige Entwicklung, die im September 2015 von den Mitgliedstaaten der Vereinten Nationen (UN) verabschiedet wurde, zielt darauf ab, mit ihren 17 nachhaltigen Entwicklungszielen (Sustainable Development Goals, SDGs) weltweit sensible Fragen der nachhaltigen Entwicklung umzusetzen. Obwohl eigentlich ein integrierter Ansatz zwischen den Disziplinen und Akteuren der Länder erforderlich wäre, hängt die Umsetzung der SDGs allerdings bisher hauptsächlich von den freiwilligen Selbstverpflichtungen der Mitgliedsstaaten ab.

In dieser Studie werden anhand umfassender Analysen drei wichtige Elemente der Agenda für nachhaltige Entwicklung bis 2030 betrachtet, erstens "Partnerschaften für die Ziele": Die Agenda 2030 betont die Bedeutung von Allianzen und Partnerschaften, wie sie insbesondere in Ziel 17 zum Ausdruck kommt. Die Zusammenarbeit von Multi-Stakeholder-Netzwerken kann vorteilhaft sein, die Bewertung ihrer konkreten Erfolge ist jedoch bisher schwierig. Die Analysen in Kapitel 2, die auf dem Beitrag der Regionalen Fachzentren zur Umsetzung der Agenda für nachhaltige Entwicklung bis 2030 basieren, untersuchen diese Kooperationen auf lokaler, nationaler und internationaler Ebene. Das zweite wichtige Element betrifft die "Unteilbarkeit" der Agenda 2030 und den Zusammenhang zwischen den Zielen; es ist allgemein anerkannt, dass die 17 SDGs stark miteinander vernetzt und sehr kontextabhängig sind. Die Auswirkungen von Ziel 4.7 auf die 17 SDGs im spezifischen Kontext werden in Kapitel 3 behandelt. Hierbei werden die stärksten Verbindungen zwischen den thematischen Nachhaltigkeitsfragen identifiziert, um positive Wechselwirkungen zu maximieren und negative Einflüsse zu minimieren. Dabei hilft es, eine Grundlage für gemeinsame Indikatoren zu schaffen, die gleichzeitig zu einer Reihe von Zielen und zur Agenda 2030 als Ganzes beitragen können. Der dritte untersuchte Aspekt der Agenda 2030 ist ihr allumfassender Charakter (All-Inclusiveness), bei dem zum Ausdruck kommt, dass jeder Beitrag wichtig ist. Dieser Aspekt wird in Kapitel 4 behandelt und untersucht unterschiedliche "Kooperationskanäle" für die Bürgerwissenschaft (Citizen Science) im Kontext der Agenda 2030, beispielsweise partnerschaftlich organisierte Netzwerkvertretungen für die Umsetzung der Ziele, Einzellösungen für bestimmte SDGs, Beteiligung an Politikzyklen, sowie Bildung und Datenbereitstellung. Um ein breiteres und wirksames Engagement anzuregen, werden Herausforderungen und kritische Aspekte erörtert sowie ein integrativer Rahmenplan vorgestellt, mit dem top-down- und bottom-up-Ansätze zusammengebracht werden.

In dieser Studie wurde die Rolle verschiedener nichtstaatlicher Akteure und Disziplinen im Prozess zur Erreichung der 17 SDGs analysiert. Sie gibt einen Überblick über die damit im Zusammenhang stehenden Schwierigkeiten, Herausforderungen und Chancen, und untersucht, inwieweit die Beteiligung der Akteure auf der Grundlage aktueller Erkenntnisse und klarer kontextueller Rahmenbedingungen basiert. Die Ergebnisse zeigen, dass die Akteure beträchtliche Anstrengungen unternehmen, um ihre Arbeit auf die Agenda 2030 auszurichten, dass jedoch zusätzliche Anstrengungen und Ressourcen erforderlich sind. Finanzielle Fragen und unklare Governance-Strukturen, unausgewogene Fortschritte bei den unterschiedlichen Zielen und Regionen, schwache Koordinationsmechanismen zwischen den Akteuren, sowie die isolierte Betrachtung einzelner Ziele etc. gelten als die größten Herausforderungen bei der Verwirklichung der SDGs.

Die Umsetzung der SDGs ist in die "Aktionsdekade" bis 2030 eingetreten. Die Schwerpunkte "global", "lokal" und "Menschen" lassen dabei Raum für die verantwortliche Einbeziehung weiterer Akteure sowie von Beiträgen aus anderen Quellen, die über die Verpflichtungen der

Mitgliedsstaaten hinausgehen. Neue, mehrschichtige Governance-Modelle sind erforderlich, um die SDGs zu koordinieren und das breite Spektrum der Akteure in diesem Prozess einzubeziehen. Globale Regierungs- und Regulierungsmechanismen auf internationaler Ebene sind notwendig, da nationale Strategien nicht ausreichen. Da Netzwerke und Partnerschaften von ihren regionalen Kontexten und weiteren Umständen abhängig sind, führt eine stärkere Zusammenarbeit mit internationalen Organisationen, die im Umsetzungsprozess der SDGs aktiv sind, zu einer besseren Wahrnehmung auf der internationalen Bühne. Die Studie bestärkt die Idee, dass nichtstaatliche Akteure sowohl auf lokaler als auch auf internationaler Ebene einen Beitrag außerhalb ihres länderspezifischen Kontextes leisten können.

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List of acronyms and abbreviations

ACSA	Australian Citizen Science Association
COST	European Cooperation in Science and Technology
CS	Citizen Science
CSA	US Citizen Science Association
CSGP	Citizen Science Global Partnership
DIY	Do it yourself
ECSA	European Citizen Science Association
ESD	Education for Sustainable Development
EU	European Union
Gap	Global Action Program
GCED	Global Citizenship for Sustainable Development
HCA	Hierarchical Classification Analysis
HLPF	High Level Political Forum
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IUSDRP	Inter-University Sustainable Development Research Programme
MCA	Multiple Correspondence Analysis
MDGs	Millennium Development Goals
NGO	Non-Governmental Organization
NRA	Network Representation analyses
RCE	Regional Centre of Expertise
SDGs	Sustainable Development Goals
SDKP	Sustainable Development Knowledge Platform
SDSN	Sustainable Development Solution Network
SI	Supplemental information
SS	Sustainability Science
UIS	UNESCO Institute for Statistics
UN DESD	UN Decade on Education for Sustainable Development
UN	United Nations
UNCED	UN Conference on Environment and Development
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNU-IAS	United National University-Institute of Advanced Studies
US	United States
VLR	Voluntary Local Reviews
VNR	Voluntary National Reviews

1. Introduction

The 2030 Agenda for Sustainable Development was adopted by United Nations (UN) Member States, in September 2015. The document contains a political Declaration, 17 Sustainable Development Goals (SDGs) with 169 targets, and a framework for follow up and reviews (UN 2015). Further, a global indicators framework, containing 244 Indicators, was developed by the United Nations Statistical Commission, and agreed upon in 2017. Annual refinements of indicators are being included in the indicator list as they occur (<https://unstats.un.org/sdgs/iaeg-sdgs/>). The SDGs build on the Millennium Development Goals (MDGs), but they apply to all countries, developed and developing. The 2030 Agenda aims to solve all sensitive sustainable issues such as to end all forms of poverty, fight inequalities and tackle climate change, while ensuring that no one is left behind (<https://www.un.org/sustainabledevelopment/development-agenda-retired/>).

The 2030 Agenda is transformative and provides a joint framework of measurements for all countries, while the 17 SDGs are focus areas for achieving sustainable development. It is a voluntary commitment, depending on the will of member states, but also on the international regulatory mechanisms and individuals. The 2030 Agenda is increasing the world population's awareness about the urgency of sustainability challenges. Since the first years of their implementation, there was a common understanding that achieving the SDGs would require a fully integrated approach between sectors, disciplines, countries, and actors. Thus, engaging mechanisms were initiated from the governments to include the business sector, civil society, academia, local governments and communities in the SDGs implementation processes and in the Voluntary National Reviews (VNR). Despite that, contributions of non-state actors can be in many forms and in different levels of governance, vertical or horizontal, and in different scales, local, national and international. There is also a necessity that the scientific community contributes to the research for the SDGs. This study, through comprehensive analyses, considers three important elements of the 2030 Agenda for Sustainable Development.

Firstly, the “**partnerships for the Goals**”: The 2030 Agenda, stresses the importance of alliances and partnerships, as explicitly expressed in Goal 17 “*Strengthen the means of implementation and revitalize the global partnership for sustainable development*”, and Target 17.16 “*Enhance the global partnership for sustainable development, complemented by*

multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries” (UN 2015). The study considers the importance of exploiting the existing partnerships with experiences in the MDGs, for the implementation of the 2030 Agenda, in conjunction to creating new ones. The collaborations of multi-stakeholder networks can be beneficial for the SDGs processes, but the impact evaluation of these networks and partnerships for the global issues remains a challenge.

Secondly, the “**indivisibility**” of the 2030 Agenda, and the interconnection between the Goals: It is widely accepted that the 17 SDGs are strongly interconnected, where the implementation of one Goal will have positive or negative effects on the others. These interrelations vary in different settings. Thus, in order to maximise synergies and positive and minimise negative impacts, scientific analyses and examinations are necessary to be done in specific contexts. This study analyses the interrelation of Goals and Targets with specific emphasis on Goal 4 “*Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*” which is considered to have a long term impact and facilitate implementation of all the SDGs, and Target 4.7 that emphasises Education for Sustainable Development (ESD) “*By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and nonviolence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development*” (UN 2015). Research regarding SDGs complex interrelations at the Target level can serve as well as a background for development of common indicators, which can contribute simultaneously to a set of Goals, and to the 2030 Agenda as a whole.

Thirdly, the “**all-inclusiveness**” aspect of the 2030 Agenda, where every contribution is valid: There are numerous approaches and entry points that diverse disciplines, through institutions, communities or individuals, can contribute to the 2030 Agenda. This study analyses Citizen Science (CS), by considering it as a valuable source for the SDGs implementation. Analyses of governance aspects of these contributions, from the bottom up and bottom down perspectives, add to the global research for the SDGs and orient these communities to enlarge and strengthen their involvement.

The study specifically answers the following research questions:

- 1) What is the role of the diverse multi-stakeholder networks for the implementation of the SDGs at different levels (local, national, international)?
- 2) What is the influence of Target 4.7 Education for Sustainable Development on the rest of the Goals and Targets, and their interconnections in specific contexts?
- 3) What are some of the “entry points” or “influencing channels” for Citizen Science to contribute to the SDGs?

1.1 Scope, Aim and Objectives

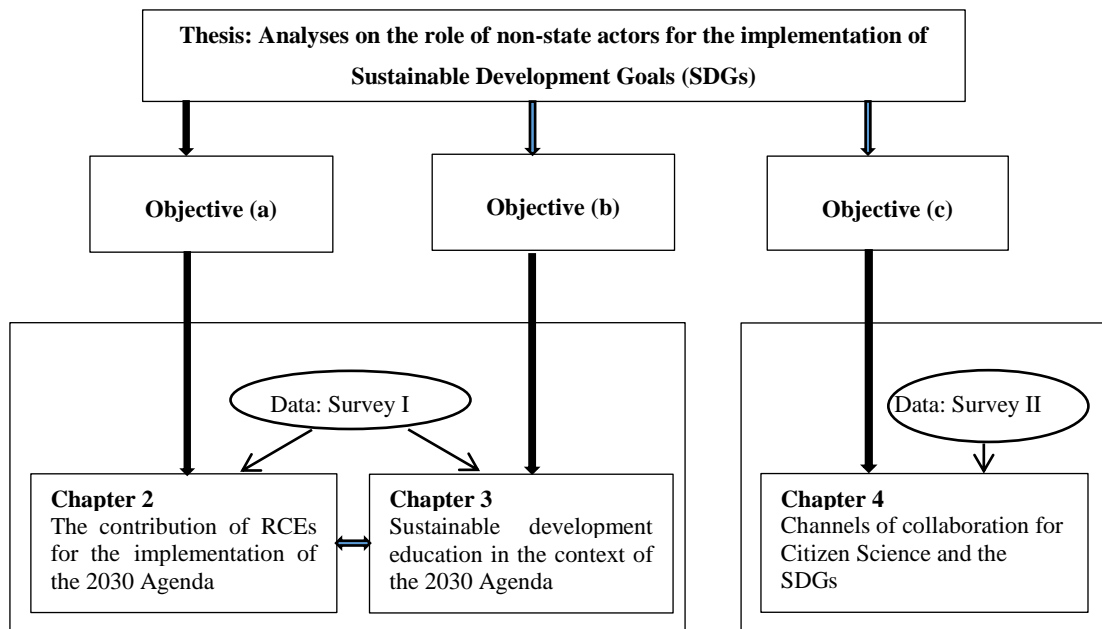
The study aims to contribute to the global research for the 2030 Agenda and the 17 SDGs. It helps to fill the research gap for “Partnerships”, “Indivisibility” and “All-inclusiveness” of the 2030 Agenda. Qualitative and quantitative techniques are used for the study: Interviews with several institutes’ representatives from different sectors (academia, public institutions, non-profits, businesses) in several European countries; a first survey, conducted with the community of global networks Regional Centre of Expertise on Education for Sustainable Development at the United Nations University’s Institute of Advanced Studies Japan (UNU-IAS) (RCEs - <https://www.rcenetwork.org/portal/>); a second survey, conducted with the practitioners of Citizen Science including the members of the COST Action on Citizen Science (CA15212 - <https://cs-eu.net/>). The Sequential Exploratory Design, a mixed method approach where the qualitative data is collected first, followed by collection and analysis of quantitative data (Schoonenboom, 2017) was used in this study. The purpose is to reveal the dynamics of networks that are not accessible solely by qualitative approaches. The incorporation of one or more methodological techniques drawn from a second method, into a single research study, serves to access part of the phenomena that cannot be accessed by the first method alone (Morse, 2009). The mixed method approach is used at the technical level, because techniques are not tied to paradigms or methods, permitting innovative uses of a range of techniques for a variety of purposes (Sandelowski, 2000). The interviews were conducted in a pre-phase prior to the data collection in the surveys, in order to get an understanding and create the necessary knowledge background for the defining the questions of the surveys. For data analyses several methods were used such as literature reviews, author’s analytical reflections, descriptive statistics, multiple correspondence analysis

combined with hierarchical classification analysis and network representation analyses (NRA) with support of the Software R (R, Core Team, 2013). The methodologies are explained in more details in the following Chapters.

Objectives:

- a) To evaluate the role of global multi-stakeholder networks or RCEs for the SDGs implementation, by analysing their interactions at local, national, international level and identifying clusters with similar characteristics in tackling specific Goals.
- b) To explore the role of ESD for the 2030 Agenda, by examining the interconnections of Target 4.7 with the rest of the Goals and Targets in the context of multi-stakeholder networks.
- c) To identify several “entry points” or “influencing channels” of CS for the 2030 Agenda, by analysing their challenges and future potential from the top-down and bottom-up perspectives.

The objectives a), b) and c), are addressed in the Chapters 2, 3 and 4, respectively. In the graph 1, the connections between the Chapters and the study objectives are visualized.



Graph.1. Illustration of the connection between study objectives, chapters and the data sources.

Chapter 2 analyses the contribution of RCEs for the implementation of the 2030 Agenda. By considering that the activation of existing partnerships to be important for the SDGs, in conjunction with creating new ones, it gives an overview of RCEs involvement, by exploring collaboration at local, national and international scale, based on data from the first survey. Through Hierarchical Classification Analysis, the networks are grouped into clusters with similar characteristics and discussions include challenges and potentials for intensifying the contributions towards the 2030 Agenda.

Chapter 3 addresses the implications of Target 4.7 on the 17 SDGs, in the context of the RCEs as global multi-stakeholder networks. It analyses the interaction of Target 4.7 with other Goals and Targets, in order to identify the strongest connections amongst thematic sustainability issues, through statistical analyses, NRA and a comprehensive literature review.

Chapter 4 explores several “collaboration channels” for CS and the 2030 Agenda, by analysing challenges and critical aspects, and by providing a framework of interactions from the top-down and bottom-up perspectives in order to encourage a broader and more effective engagement. The analyses are based on information from the current practices and opinions of practitioners, researchers, scientists, policy makers, citizen scientists, and organizations that involve citizens in scientific projects, and representatives of CS networks.

2. The contribution of Regional Centers of Expertise for the implementation of the 2030 Agenda for Sustainable Development

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2.1 Abstract

The implementation of the 2030 Agenda for Sustainable Development and the achievement of the 17 Sustainable Development Goals requires a fully integrated approach between sectors, disciplines, countries, and actors. On the fourth year of its implementation, the uptake of SDGs from non-state actors is increasing around the world, by developing engaging mechanisms for involvement at horizontal and vertical level. Considering that activation of existing partnerships is important for SDGs, in conjunction with creating new ones, this research has analysed the approach of global network of Regional Centres of Expertise on Education for Sustainable Development. An overview of involvement is done based on a survey data, by exploring collaboration in local, national and international scale. Through Hierarchical Classification Analysis, the networks are grouped into clusters with similar characteristics and discussions include challenges and potentialities for intensifying the contribution towards the 2030 Agenda.

2.2 Introduction

The implementation of the 2030 Agenda for Sustainable Development and the achievement of the 17 Sustainable Development Goals (SDGs) require a fully integrated approach between sectors, disciplines, and countries, calling for new strategies addressing a wide range of actors, such as civil society, businesses, academia, regional and international bodies (Caiado et al., 2018). The 2030 Agenda emphasises the role of multi-stakeholder partnerships as a way to engage with and enhance cooperation, explicitly in the Goal 17, “*Strengthen the means of implementation and revitalize the global partnership for sustainable development*”, and Target 17.16 “*Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge,*

expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries”.

Taking into account the importance of partnerships for sustainability, this research analysed the extent to which the 2030 Agenda for Sustainable Development and the 17 SDGs are being implemented by multi-stakeholders networks, specifically among the Regional Centres of Expertise (RCE) on Education for Sustainable Development (ESD). The United Nations University, in Japan, established the first group of seven RCEs in 2005, as a response to the UN Decade on ESD from 2004 to 2014. There are at present 159 RCEs distributed around Africa, North and South America, Asia-Pacific and Europe (<http://www.rcenetwork.org/portal/rces-worldwide>). They are designed as networks of existing regionally located stakeholders including educational institutions, business, local governments, non-profit organisations and individuals, aiming to translate global objectives to local communities (Mochizuki and Fadeeva, 2008). Governance, collaboration, research and development, and transformative education are at the core of each RCE, acting not as physical centers but as institutional mechanisms to facilitate shared learning for sustainable development (UNU-IAS, 2014). RCEs apply different governance structures according to the affiliated organisation, responsible for coordinating the partners. When universities establish alliances with Regional Centers of Expertise on Education for Sustainable Development, their engagement in regional actions for sustainable development is increased compared to others (Sedlacek, 2013).

The scope of the work of RCEs is closely linked to regional sustainability challenges such as sustainable consumption and production, climate change, energy efficiency, vocational training, entrepreneurs’ education, eco-tourism, health and well-being, biodiversity and ecosystem services, traditional knowledge, and disaster risk reduction. Within the learning networks, the change of communication during stakeholder learning processes creates conditions for a systemic shift in education to sustainability (Dlouha et al., 2013). RCEs aim to tackle ESD at all levels, especially focused on two important elements such as to consider education as a means towards sustainability and to consider sustainability as an important part of education (UNESCO, 2018).

It is argued that the implementation of the SDGs would require alternative governance frameworks, including sustainable governance, horizontal versus hierarchical, meta governance, or collaborative governance which crosses sector boundaries for a successful performance and public engagement (Emerson, 2012). Multi-actor collaborations are necessary for sustainable orientation of societies, and often due to the complexity of

sustainable development challenges, governance through networks is preferred (Meuleman and Niestroy, 2015). The principles embraced in SDGs can be translated into policy making if, among others, countries are supported by global economic governance (Leal Filho, 2019a). The SDGs offer an innovative approach of global governance, with goal-setting features, which are crucial for the governance strategy (Biermann et al., 2017).

The “indivisibility” is considered a crucial point of the 2030 Agenda, recognizing that human development and prosperity are co-dependent across country boundaries (Nilsson, 2017). In the fourth year of implementation, the uptake of SDGs from different actors around the world is increasing. National governments of the member states have created engagement mechanisms like national councils, inter-ministerial groups, multi-stakeholder committees and sustainable development commissions, in order to fulfil their voluntary commitments. Despite the global dimension, the implementation of the SDGs depends on the degree of commitment of each country and their prioritization of sustainability (Salvia et al., 2018).

Core elements of the 2030 Agenda for Sustainable Development are the follow-up mechanisms that review progress at the national and sub-national levels, and which have to be inclusive and provide a platform for partnerships of major groups and other relevant stakeholders. Paragraph 79 of the 2030 Agenda calls on Member States to conduct regular and inclusive reviews of progress at the national and sub-national levels, drawing on contributions from civil society, marginalized groups and others. Local governments are mobilizing resources for localizing SDGs, and are establishing diversified partnerships, thus applying multi-level governance and multi-stakeholder engagement for greater accountability, ownership, and coherence (nrg4SD, 2017). UN Global Compact through the multi-year strategy “Making Global Goals Local Business” encourages businesses of every size and give support for achieving the SDGs by 2030 (United Nations Global Compact, 2017). Academia and educational institutions can contribute to the SDGs in research, education, operations, governance, and external leadership, according to the Sustainable Development Solutions Network (SDSN 2017). Key governance challenges, such as stakeholders' collective action and inclusive decision making, trade-offs and accountability, are considered crucial for implementing the SDGs (Bowen et al., 2017).

This research stresses that collaborative action in multi-stakeholder platforms may diffuse the challenges that organisations face with the implementation of the SDGs. Some of the reasons that prevent non-state actors to advance the 2030 Agenda are, among others, weak capacities among some sectors of civil society for national development planning; the fact that many private sector parties perceive sustainability as a barrier to their activities; academia being

often disconnected from development planning processes; and the lack of capacities to produce policy-relevant information (UNDP, 2017). The involvement of universities in local and regional development processes requires new collaborative ways for knowledge transfer, which can be determined in collaboration with local and regional societies (Peer and Stoeglehner, 2013) and brings about mutual benefits and synergies on sustainable development (Leal Filho et al., 2019b)

The governance and sustainability aspects of the SDGs require coordination at different levels. Each level contains complications and limitations, i.e. coordination at the central level is somehow influenced by the degree of independence of other stakeholders and their focus agendas. Insufficient interactions among stakeholders in national networks, and insufficient coordination of actions may not support integration of sustainable development to educational organisations (Vargas et al., 2019). International coordination risks remaining at higher levels, excluding the enormous actions and connections that exist at other, or lower levels. Coordination of the partnerships mainly exists in a horizontal level, but depends on the will, availability and interests of the partners. Networks as an instrument of modern governance can lead to joint policy making, where autonomous members partially interact according to their different interests (Ruggie, 2002).

Although the impact of scale is complex, because action taken in one spatial scale can have diverse impacts on other scales (Scharlemann et al., 2016), RCEs allow for a distinct definition of scale, perceiving the local level as a wider geographic and knowledge space for practice dissemination (UNU-IAS, 2010). Public, private and civic sectors, in order to identify challenges and direct financial resources can use the data and metrics as a useful management tool in the SDGs context (Mulholland, 2018). The identification of SDGs with regional sustainability challenges for RCEs is a work in progress. Sustainable Development Goals can contribute to better understand sustainability challenges but it is necessary to have a continuous consideration for this mutual link otherwise too much effort will be used for SDGs implementation without addressing in practice the sustainability (Leal Filho, 2019a).

The 17 SDGs, adopted in 2015 to implement the 2030 Agenda for Sustainable Development, contain 169 Targets and 234 Indicators. While Goals are ambitious, transformational and limited in number, Targets are more specific and measurable and contribute to achieving one or more Goals (SDKP, 2014). The indicators create the framework for monitoring and assessment in order to communicate the results to all the sectors of society (Janouskova et al., 2018). The interactions among the SDGs are context dependent and their effects are highly influenced by application of appropriate governance (Nilsson, 2018).

This study analysed the collaborations for the SDGs in a horizontal and vertical level, at regional, national and international scales, and identified clusters with similar characteristics in tackling specific Goals. In addition, it aimed at addressing the question: “What is the role of the multi-stakeholder networks for the implementation of the SDGs in the local level?” thereby providing an overview of the current involvement of the RCEs global network.

2.3 Methodology

To approach the research question, the authors used a quantitative, descriptive method of data collection. A survey was developed and conducted (April-July 2018) within the global network of 159 RCEs, using a list-based sampling frame. Details about it were published in the RCEs e-bulletin 82: June 2018 (Global RCE Network, 2018) and on the Facebook Page of the Global RCEs Network. The survey was voluntary and anonymous and consisted of 25 questions divided into four sections: 1) RCEs and their involvement with the SDGs, 2) networks links within regions and countries, 3) network links in the international context, and 4) barriers, challenges and opportunities, as presented in Appendix A. Despite diversities, such as years of establishment, number of partners, intensity of actions, and variety of sustainable regional challenges, the general design of RCEs is based on common features and functionalities that are crucial for their establishment. In this aspect, the study takes into consideration the similar features that characterise RCEs, and the analyses are based on the total number of respondents, independently from their continental divisions.

The analysis of the results is divided into three sections, as summarised in Table 1 and presented as follows:

Table 1. Overview of how the results were structured and the research questions which guided the analysis.

Section	Associated research question	Questions from the survey
(a)	1) To what extent are the RCEs networks involved with the SDGs implementation?	1-12; 15-20
	2) What is the degree of interaction between actors of different types of organisations in horizontal scale?	
	3) To what extent are these networks connected at national and international levels?	
(b)	4) What are similar characteristics of RCEs that deal with specific goals?	All
(c)	6) Which are the challenges and opportunities in dealing with the SDGs?	13, 14, 21-25

The purpose of section (a) is to answer research questions related to involvement of RCEs with the SDGs and their connection in national and international levels, giving a general overview of current involvement of RCEs with sustainability. Section (b) classifies RCEs into groups by using the statistic method of Multiple Correspondence Analysis (MCA) combined with a Hierarchical Classification Analysis (HCA), with support of the Software R (R, Core Team, 2013). MCA allows converting nominal data to quantitative data that can be used for hierarchical clustering.

The advantages relay in extracting the most relevant information by combining different survey answers, and in identifying similarities of the participants from a multidimensional perspective. It is appropriate to perform clustering on principal components, because MCA associates quantitative variables that summarize all categorical variables (Husson and Josse, 2014) and allows for minimum loss of information when aims to reduce dimensionality (Lautsch and Plitchta, 2003).

The data from survey contained only nominal responses. No higher order of data was used for the MCA analyses. Survey data were uploaded into Excel and analysed in software R. The first step of MCA is to recode the data, so the data were elaborated accordingly (for instance by indicating the missing values in the data set, from the unanswered questions, with N.A, and coding the answers with values 0 and 1).

A limitation of this approach is that it is a descriptive one. The results cannot be generalized to the whole population since they concern only the sample that has answered the survey. Thus no inference or generalizing to the whole population is made. The purpose is to answer the research question connected to similar characteristics among RCEs and work with the SDGs.

Section (c) analyses responses from the survey and builds upon the previous sections in order to present challenges and opportunities in dealing with the SDGs in order to indicate the areas of intervention and to give a guideline on how to strengthen the contribution and further involvement of RCEs for the 2030 Agenda for Sustainable Development.

2.4 Results and discussion

There were in total 31 replies to the survey (19.5 percent response rate), belonging to the four RCEs continental groups, respectively 14 from Europe, 8 from Africa and Middle East, 5 from Asia-Pacific, and 4 from the Americas. The total response rate for answers of the 24 questions was 93 percent. The results are structured in 4 sections, as presented in the methodology: a) RCEs involvement with the SDGs in a regional, national, and international context; b) RCEs clustering according to similarities in dealing with the SDGs; and c) challenges and opportunities of RCEs dealing with the SDGs.

a) RCEs involvement with the SDGs in a regional, national, and international context

RCEs networks consist of about 10e70 regional partners, where “region” means part of a country or borders between countries. The governance structure of an RCE differs according to the host or affiliated organisation responsible for the partners’ coordination. The host organisations belong to educational institutions, non-profits or civil society, but also to enterprises/companies or local/ central governments. At a global scale, most of the RCEs are facilitated by a higher education institution, which also applies to participating RCEs in this study. Approximately 60 percent of them are hosted by educational institutions, 42 percent by non-profit organisations, 16 percent by local governments, 16 percent by businesses, 6 percent from central governments and in 6 percent of the cases they are independent of any host institution. The partners’ constellations and types differ (see Fig. 1).

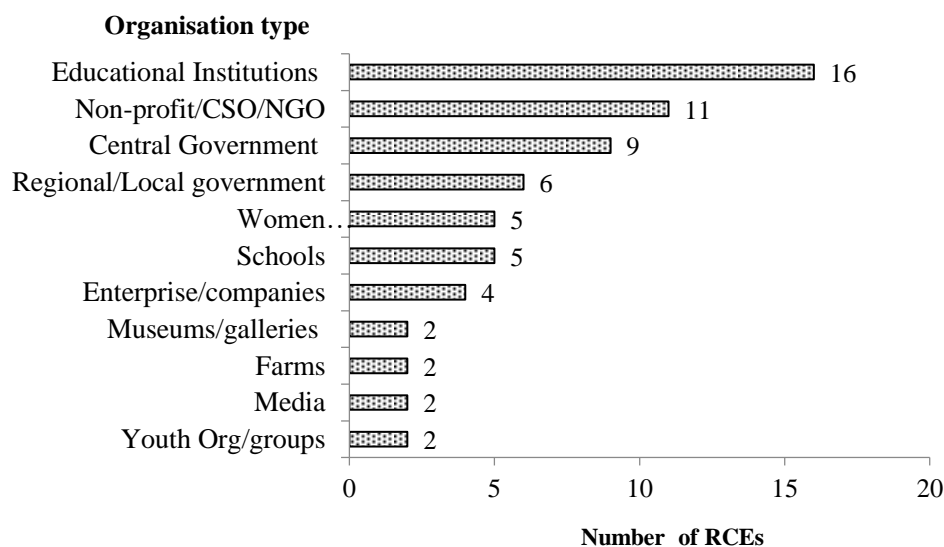


Fig. 1. Types of partner organisations of RCEs and number of RCEs that contain these types of in their network

Based on self-perception, 87 percent of the RCEs believe they are strongly involved with the SDGs. The core focus of RCEs, Education for Sustainable Development (ESD), is a crucial part of the 2030 Agenda for Sustainable Development. ESD is explicitly mentioned in Goal 4, Target 4.7, “By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through Education for Sustainable Development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and nonviolence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development”. Consequently, the results of the survey indicate that Goal 4 was used by 84 percent of the respondents, although prioritization of the SDGs locally appears to be strongly connected with efforts to contribute to the entire 2030 Agenda. Consequently, 48 percent of respondents deal with the 2030 Agenda as a whole, 58 percent of them with several Goals and only 10 percent deal with Goal 4 separately. Ranking of most used Goals from RCEs is shown in Figure 2. No clear involvement with Targets and Indicators was identified at this stage, except for Targets of Goal 4 (the most selected, target 4.7, used by 84 percent, targets 4.c, by 55 percent, and targets 4.a by 45 percent of respondents). The most underestimated Goals appear to be SDGs 1, 9 and 10.

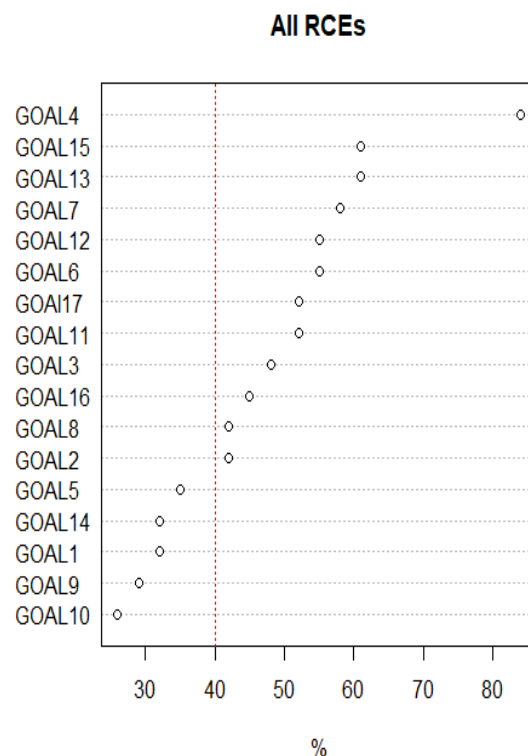


Fig. 2. Ranking of the 17 SDGs, (from the least to the most used) according to the number of RCEs expressed in percentage

Level 1 - Regional: Strong features of RCEs enable horizontal cooperation, aiming for equal partnerships assured by organisational structures and decision-making processes. Regarding the actions for SDGs, 77 percent of RCEs operate in a horizontal or bilateral consortium, 32 percent of them are leading the process and in approximately 26 percent of the cases, collaboration is vertical, depending on the funding source.

Survey results show that RCEs are currently involved with projects and actions for SDGs, ranging from 1 to 14 for each respondent. The initiatives consist of research for SDGs (45 percent of the respondents), development projects (71 percent), advertising campaigns (39 percent), but also lectures at universities, SDGs books designed for teaching and community development. Nevertheless, the outreach of cooperation is not limited to their partner organisations. Seventy-four percent (74 percent) of RCEs are collaborating with other multi-stakeholder regional networks and 55 percent with sectoral networks, i.e. the networks of educational institutions, universities or schools.

Level 2 - National: No strong involvement in national processes for SDGs was identified in this survey. Only 39 percent of RCEs participate in local governments' actions toward the 2030 Agenda and consultation processes to respective national/local governments, and 23 percent are part of national committees, 23 percent collaborate only for SDG4, and 19 percent in monitoring and tracking of SDGs progress. Since 2016, according to the Sustainable Development Knowledge Platform, 112 countries have conducted voluntary national reviews (VNRs), 22 in 2016, 43 in 2017, and 47 countries in 2018 (SDKP, 2018). Additional 36 countries are expected to conduct them by 2019, and all countries to complete the VNRs around three times during the 15 years. The aim is to facilitate the sharing of experiences, successes, challenges, and lessons learned, in order to accelerate the implementation process, but also to strengthen policies and mobilize multi-stakeholder support and partnerships for the implementation of SDGs. Our results indicate that only 26 percent of RCEs have so far been part of a VNR country process, 52 percent were not involved and 19 percent intend to be involved in the coming years.

Level 3 - International: Non-state actors should engage in the 2030 Agenda for Sustainable Development not only through national governments. Regional stakeholders can effectively collaborate with similar organisations and networks outside their country boundaries. RCEs collaboration in the international arena for the SDGs is mainly within the RCEs global

network. About 61 percent of RCEs collaborate within global RCEs network and the RCEs coordination Centre at UNU-IAS in Japan, but especially in continental clusters. Further collaborations are with international networks and organisations such as UNESCO, UNDP, Copernicus Alliance, ESD Expert-Net, Erasmus+ Program, Learning Cities, Joint Programming Initiative Urban Europe, and Global Consortium for Sustainability Outcomes Network, European Consortium of Universities for Innovation, IPBES, Living Knowledge, Earth Charter, and LAG-21, KYUSYU, EPO.

b) RCEs clustering according to similarities in dealing with the SDGs

Hierarchical clustering and factor map analyses enabled the grouping of RCEs into three clusters with similar characteristics, by extracting information from the survey answers (see Fig. 3). The cutting is done into 3 clusters. The cutting into 2 clusters is considered insufficient to explain the diversity, while for more than 3, clusters would contain a very small number of respondents.

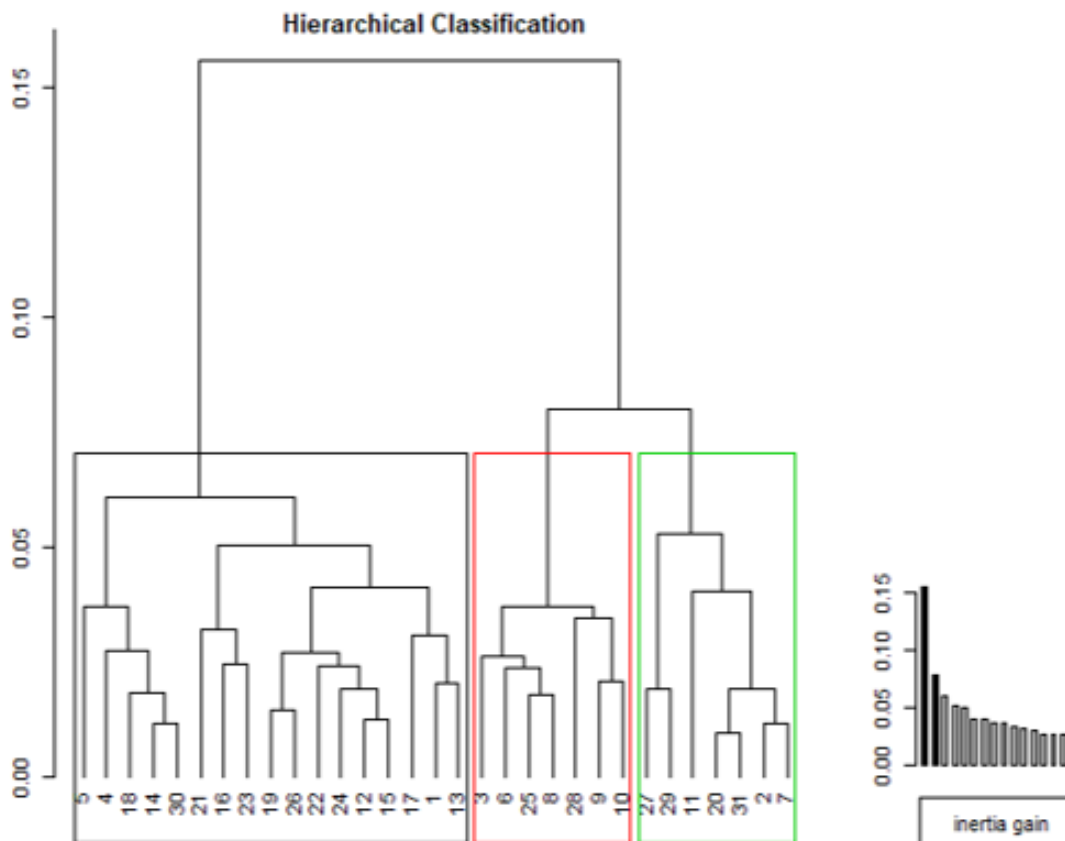


Fig. 3. Hierarchical Clustering of RCEs. Numbers horizontally correspond to the 31 respondents. Cluster 1 shows respondents in black colour, cluster 2 in the green and cluster 3 in red. The cut is performed at the level of 0.075 (inertia gain) as suggested by the Software R. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Cluster 1 is the biggest with 55 percent of respondents. It is named “ESD focused RCEs”, because respondents of this cluster are particularly focused on Goal 4, Target 4.7 on Education for Sustainable Development. Additional parts of their work include Goals 13, 14 and 15 as well. These RCEs are equally distributed among continents and affiliated to diverse organisations but mainly educational institutions and non-profits ones. They are self-perceived as “moderately involved” with SDGs. Their collaboration in vertical scale is weak. They mostly operate in development projects for SDGs, in horizontal or bilateral collaborations. For these RCEs, changes in leadership and governance are considered crucial, in order to adapt to the new global objectives. They favour the bottom-up approach to deal with SDGs and consider the networks informality as a factor which fosters collaboration. The major challenge of the participants of this cluster is lack of resources and funds.

Cluster 2, named “Thriving RCEs”, belongs to 19 percent of respondents. They are mostly located in Europe and affiliated to educational institutions. Their focus is on Goals 17, 4, 16, and 11 and Targets 4.1, 4.5, 4.7 and 4. c. They are self-perceived as “strongly” to “very strongly” involved with the SDGs, mainly through research and advertising/campaigning. They contribute in national level through participation in VNRs, and in consulting national/local government for the SDG. These RCEs are characterized by long term financial stability. Collaborations between network partners are horizontal, bilateral or vertical depending on funding scheme. They favour a focus-oriented approach for SDGs and consider informality of networks to have a passive impact to their work.

To Cluster 3, of “Polyvalent” RCEs, belong 26 percent of respondents. Fifty percent of them are located in Europe and 50 percent in other continents. They are affiliated by diverse organisations. Their actions for SDGs cover Goals 1 to 15, and specifically Targets, 4.3, 4.4, 4.5, 4.7, 4.a, 4.c, and range from research and advertising/campaigning to development projects. Self-perceived as “strongly” involved with SDGs, they operate in horizontal or bilateral collaborations but also as leaders of the actions for the SDGs. In vertical level they contribute in national committees for the goals, to VNRs, local government actions. These RCEs are more active in cooperating with international organisations. Their approach towards the SDGs is a combination of bottom-up and top down, and they consider the 2030 Agenda as a method to measure impact. Funding for SDGs remains a challenge.

In Fig. 4, are displayed the most used Goals by the RCEs, according to the three clusters. The analysis shows that “ESD focused RCEs” clearly focus on Goal 4, and very few of them are involved with Goal 17. On the other hand, SDG 17 appears to be strongly at the focus of

“Thriving RCEs”. Based on the characteristics of the clusters described above, the Polyvalent” RCEs, which are characterized by very diverse partners, are focused in almost all 17 Goals, while the RCEs that are based in Europe have a stronger commitment to their country processes.

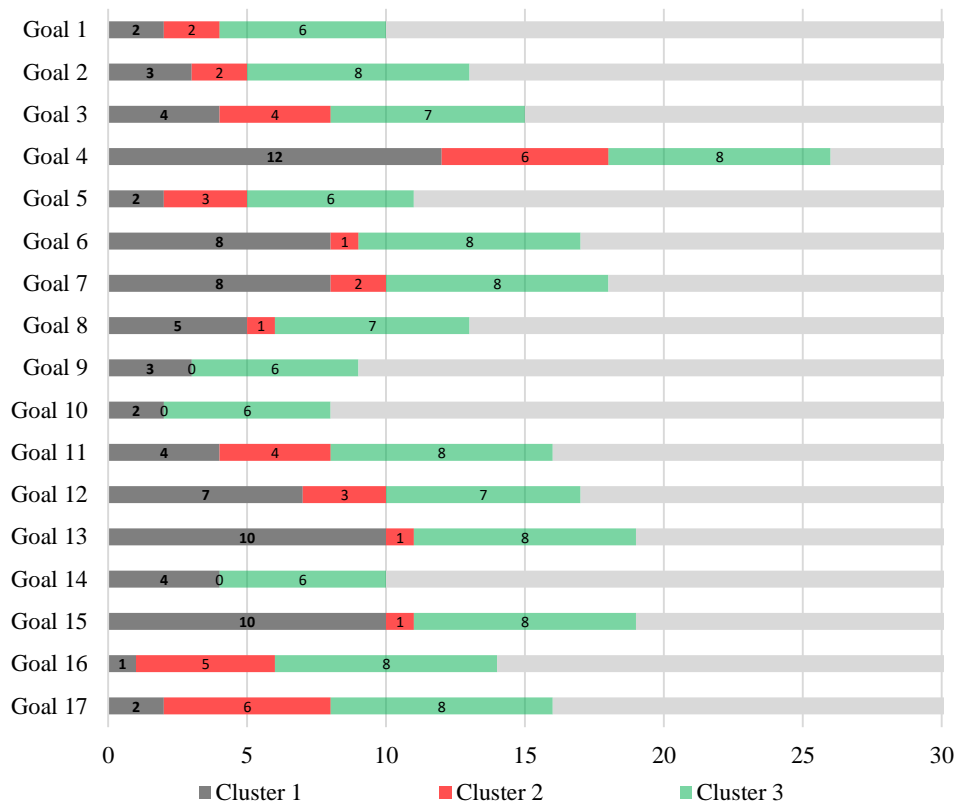


Fig. 4. Number of RCEs working with each of the SDGs ordered by clusters

c) Challenges and opportunities of RCEs involvement with the SDGs

Since 2015, RCEs networks have experienced difficulties in explaining their unique concept to local stakeholders, in securing long-term financial stability, in promoting and making visible their work. Despite that, additional issues are identified by this study, which can affect their approach towards the SDGs. The challenges and opportunities discussed in this section derive from the results of the survey and analysis from the previous sections.

Due to the timeline of the 2030 Agenda for Sustainable Development, a sense of urgency is needed for RCEs to adopt to changing global objectives. Although the majority of respondents (48 percent) consider the process a continuation of their work on the Millennium

Development Goals, 69 percent of RCEs agree that changes are needed for adapting to SDGs and only 3 percent of respondents believe this is not part of their focus.

The complexity of the 2030 Agenda, the ambiguity about Targets and Indicators, and the lack of sufficient indicators for some of the Targets increase difficulties to measure and scale down. Although 29 percent of RCEs find the SDGs Indicators framework useful for measuring their impact, our analysis indicates an active involvement of RCEs with Goals in general but with no clear connection to specific Targets and Indicators.

Governance challenges are related to issues such as vertical outreach, horizontal outreach, equal partnership and access in the decision process, and need for structural changes. Autonomy from the hosting organisation is considered as an obstacle only by 19 percent of RCEs. The majority of respondents are hosted by educational institutions, but despite that they are more involved in development projects for SDGs. Consequently, in general no clear link was identified between the hosting organisation and the SDGs actions which assure for positive impact of RCEs outside the hosting organisations. It is also an indication of the expansion of the activities of educational institutions with a broader focus when it applies to the SDGs. The necessity to expand the network with new partners for SDGs is stressed by 74 percent of RCEs. But these networks are voluntary and flexible, thus not always can choose the most influential stakeholders. As a consequence, the network expansion does not always apply to the most effective regional actors with a stake in the SDGs. Another identified challenge is to engage existing partners in long term commitments for SDGs. The results of our survey indicate RCEs partners deal independently with the SDGs in 65 percent of respondents, those not involved are 13 percent, and 19 percent might get involved in the future. Despite the fact that the contribution of RCEs can be comparatively modest to the requirement of the regions, these networks can act as agents for directing and orienting partner organisations towards the SDGs. Attempts to include SDGs in the large industry and business sector are more successful compared to small-medium size enterprises. The mobilisation of such enterprises, which are often partners of RCEs, can facilitate localizing the SDGs.

Vertical outreach requires a stronger involvement in the country processes and Voluntary National Reports. Vertical integration is considered crucial for the implementation of the 2030 Agenda, depending on among other factors from the political will at central level, resources and capacities to deal with Targets and Indicators, and the degree of involvement of the non-state actors. Although additional efforts are required for participating in countries SDGs processes, it can be a means to increase RCEs visibility, and contribute to the

accountability of these processes. Furthermore, by participating in the SDGs monitoring RCEs can align their internal evaluation processes with the SDGs metrics and data management tools.

Regarding structural changes, only 10 percent of RCEs perceive changes in leadership and governance structures to be necessary for the SDGs process. For future involvements, they prefer mutual coordination (top-down and bottom-up approaches). A majority of them (55 percent) believe in a bottom-up approach led by their networks to be more effective for SDGs implementation, while 32 percent of respondents believe in a top-down approach, preferably led by national or international organisations. Forty-five percent of RCEs prefer to use a focus-oriented approach for selected Goals, only when intersected with their thematic issues. For a bigger involvement in the international context, participants stress the need for stronger cooperation within the global RCEs network and other international networks, as well as the provision of guidance and resources from the RCEs coordination centre. The informality of the networks can have adverse effects in the SDGs processes. RCEs are often informal (not necessary legally registered in their countries), ranging from loose networks to, in some cases, solid organisations. This has played a role in their flexibility to deal with regional challenges. The networks' informality is perceived to have a positive impact in their current work for SDGs by 65 percent of respondents, negative impact by 35 percent (i.e. by weakening work visibility) and passive impact (difficult to measure) by 26 percent of them. Only 10 percent of respondents consider it a factor that can undermine their involvement in the SDGs processes. The results of the survey identify the lack of financial resources for the SDGs as the biggest obstacle. Establishing long term financial mechanisms, need for additional resources are considered a major challenge by 94 percent of respondents. SDGs financing require multiple channels not only from member states and international organisations but other sectors as well. Effective private sector engagement can be a considerable additional source. Usually, to encourage joint commitments, multi-stakeholders' networks deal with more financial difficulties than lone sectors (society, business, public sector, academia), thus securing access to "funds for SDGs" which can be an approach to revive networks cooperation.

2.5 Conclusions

RCEs are acknowledged as an interface of education, research, policy and practice for sustainable development. Their position between regional-international allows for a promising contribution toward SDGs, beyond national commitments. The results of the study show that, despite a slow process and an overall confusion about the 2030 Agenda, RCEs in cooperation with their regional partners, are dealing with most of the Goals. Stronger cooperation with international organisations active in SDGs would secure them a better position in international arena. In addition, participating more actively in national processes for SDGs would increase work visibility and vertical outreach.

Since networks are dependent on their regional contexts and other circumstances, despite unique aspect of the global RCEs network, it is difficult to generalize the results based on the total number of the respondents. Clustering the RCEs has shown that characteristics such as governance styles, leadership, number and type of partners, hosting organisations, can define their overall approach and focus on specific Goals. RCEs are dealing with the 2030 Agenda as a whole, confirming its indivisibility, despite their universal aim to influence policies though Education for Sustainable Development. Only one of the clusters was clearly focused on Goal 4, Target 4.7. Existing networks and platforms active in sustainable development need additional efforts and resources to commit to new global objectives. Engagement in innovative mechanisms for localizing SDGs can facilitate revitalization of these formal or informal networks. In order to help RCEs redefining objectives and setting priorities for the future, the study suggests the following recommendations:

- Create a sense of urgency for adopting to the 2030 Agenda.
- Increase the participation of the business sector for joint commitments for the SDGs.
- Increase horizontal outreach by extending network with new influencing partners with interest in SDGs related issues.
- Increase partner's access to network decision making process.
- Engaging the existing partners in long term commitments for the SDGs.
- Increase vertical outreach, by bigger participation in SDGs national processes, such as national committees for SDGs and in preparation of NRVs.
- Align SDGs monitoring framework with the internal evaluation processes.
- Encourage collaborations for SDGs with other RCEs through RCEs global network.
- Establish collaboration with the international organisations active in SDGs processes.

- Encourage joint financial commitments among the network partners for the SDGs.
- Identifying and secure access to financial channels for the SDGs.

Some limitations of this study are the extent of participation from the global RCEs community, especially those outside Europe, and the lack of information on their work with specific SDGs Targets and Indicators for enabling a more in-depth results on their interactions.

2.5.1 Implications for theory and practise

Theoretical contribution of the paper consists of a review of the literature about the governance and partnerships for sustainable development, and state of the art on the work of the RCEs.

The practical contribution is related to the fact that the study addresses the operation difficulties and issues to approaching the SDGs as part of the work of the RCEs, thus filling a research gap in this aspect and adding a degree of novelty to the work. Multi-stakeholder partnerships can positively address global change, but to evaluate, understand and improve it, remains a challenge for researchers and practitioners (Pattberg and Widerberg, 2016). Ambiguity regarding the goals and monitoring mechanisms challenge the link between the output and impact of multi-stakeholder partnerships for sustainable development, asking for testing of their advantages toward the SDGs (Pattberg and Widerberg, 2014). Scholars from different perspectives have analysed the role of networks and partnerships for sustainable development. From the policy perspective, networks contribute to the creation of a benchmark for policy development, by increasing consistency among member institutions (Dlouha et al., 2018). Complex social and environmental issues call for cross-sector social partnerships, where partner diversity, and especially non-profit sector involvement, activates transformative social change (Yan et al., 2018). Although, there is a necessity to identify the circumstances under which multi-stakeholder partnerships can be effective, they can represent a fundamentally innovative approach to achieving the SDGs with substantial results when certain conditions are met (GIZ, 2017).

3. Sustainable development education in the context of the 2030 Agenda for sustainable development

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3.1 Abstract

Education for Sustainable Development (ESD) is a concept that evolves in line with emerging sustainability issues. In the 2030 Agenda for Sustainable Development, ESD is embraced in Goal 4, Target 4.7, and reflected in other Goals and Targets. The approach towards the 2030 Agenda is important, not only because of the crucial role that education will play in the implementation of the Goals, but also in increasing its impact by orienting towards the emerging sustainability challenges. Therefore, there is a high demand for research to better understand ESD interactions with the 2030 Agenda framework in specific contexts. This study addresses the implications of Target 4.7 on the 17 Sustainable Development Goals, in the context of the Regional Centres of Expertise on Education for Sustainable Development as global multi-stakeholder networks. It analyses the interaction of Target 4.7 with other Goals and Targets, in order to identify the strongest connections amongst thematic sustainability issues. The findings revealed through statistical analyses and a comprehensive literature review, that the prevailing components of ESD are strongly interconnected with Goals 2, 3, 4, 7, 11, 12, 13, 15. Thus reinforcing that, the multidimensional aspects of ESD in relation to the SDGs are stronger regarding the current complex issues such as, education, climate, energy, sustainable cities, natural habitat, consumption and production. Although the nature of multi-stakeholder networks allows for diverse approaches of ESD towards the 2030 Agenda, the study indicates the importance of partnership and informal learning for reflection of global sustainability issues in regional platforms.

3.2 Introduction

Education for Sustainable Development (ESD) is an evolving concept, whose many interpretations are relevant to local and national circumstances, as it adapts to the specifics of political, socio-cultural, and ecological contexts (UNESCO 2017). This concept reached major recognition during the United Nations (UN) Decade on Education for Sustainable Development (DESD) (2004-2014), with the adoption of the 2030 Agenda for Sustainable Development. ESD is embraced by Goal 4, Target 4.7 of this plan, “By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through Education for Sustainable Development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and nonviolence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development” (UN 2015).

Nevertheless, the concept and values of ESD is diffused throughout all 17 Sustainable Development Goals (SDGs). Other Targets related to education (according to the SDG-Education 2030 Steering Committee Secretariat) namely “Education within the 2030 Agenda for Sustainable Development” are: Target 3.7, SDG3, “Health and well-being”, Target 5.6, SDG5, “Gender equality”, Target 8.6, SDG8, “Decent work and economic growth”, Target 12.8, SDG12, “Responsible consumption and production” and Target 13.3, SDG 13, “Climate change mitigation” (<https://sdg4education2030.org/the-goal>).

The UN Educational, Scientific and Cultural Organization (UNESCO), the global leader of data for education, is responsible for 22 measurement indicators that significantly contribute to SDG4 concerning quality of education. The dissemination of the progress of these indicators is done through the UNESCO Institute for Statistics (UIS) databases. There are 232 Indicators for the 17 SDGs, and the role of international institutions appointed as “custodian” agencies is to collect data from national sources and compile internationally comparable estimates (UNDESA 2017). Some of the Indicators cover more than one Goal, which requires the development of new assessment methodologies (Casini 2019).

The importance of education for the 2030 Agenda is acknowledged in the six transformations needed to achieve SDGs proposed by Sachs et al. (2019). The first transformation emphasises the need for three sets of interventions: (1) to promote education, (2) to reach gender equality, and (3) to decrease inequality. Due to the interdependence of sustainability challenges across SDGs, a successful implementation of Goal 4 (which is also considered to be a means of

implementation across the entire 2030 Agenda) can influence the success of other Goals (Leal Filho 2019). ESD can sustain the future impact of the SDGs through its social dimension that enables cultural reproduction and a holistic interpretation of knowledge (UNESCO 2018a). Although recognized in Target 4.7, there is insufficient clarity within the set of indicators to demonstrate achievements for ESD. Thus, among the requirements needed for ESD in relation to the SDGs framework, intrapersonal competences and an emphasis on non-formal learning is integral to success (Giangrande et al. 2019).

The 2030 Agenda, due to the sustainable development thematic issues that it contains, encourages sustainability research (Leal Filho 2018). Research for the ESD, as an integral element of SDG 4, becomes more crucial when considering the contribution of education to all the Goals. Nevertheless, the ambiguity of ESD impact, and the complex and indivisible character of the 2030 Agenda, increases the need for understanding these interrelations which can be achieved through mapping and measuring the interactions between the Goals and Targets in specific contexts. The SDG Summit in September 2019 stressed the need for new scientific research and its subsequent adoption to specific local and regional contexts in order to exploit Goal synergies and look beyond 2030 (UN 2019).

This study describes the evolution of ESD over the last two decades through a comprehensive literature review. The interconnection of Target 4.7 with other goals is analysed, with the purpose of identifying the areas where ESD can have the strongest contribution towards several thematic sustainability issues embraced in the 2030 Agenda. A statistical analysis of interactions between Target 4.7 with a group of selected targets is done with the aim of illustrating the strongest interactions on the target level.

Data were collected through a survey conducted within the network of the Regional Centres of Expertise on Education for Sustainable Development (RCEs). ESD is recognized for accelerating and advancing sustainable solutions at a local level, i.e. via multi-stakeholder networks such as the RCEs which were acknowledged by United Nations University Institute of Advanced Studies (UNU IAS) during the UN Decade on ESD (UNU-IAS 2014). The ESD Programme at UNU-IAS has created a global network of more than 150 RCEs worldwide. “The RCEs provide a framework for strategic thinking and action on sustainability by creating diverse partnerships among educators, researchers, policymakers, scientists, youth, leaders within indigenous communities and throughout the public, private and non-governmental sectors” (UNU-IAS 2018b).

The purpose of this paper is to explore the role of ESD in the 2030 Agenda by examining the interconnections of Target 4.7 with the rest of the Goals and Targets in the context of multi-

stakeholder networks. Based on the findings, literature reviews and authors' reflections, the study provides insights into the prevailing issues of ESD toward SDGs, in the context of diverse networks, for a better understanding of potential future interpretations of ESD under the umbrella of the 2030 Agenda.

3.3 Defining Education for Sustainable Development (ESD)

UNESCO's definition of ESD states that "Education for Sustainable Development empowers learners to make informed decisions and responsible actions for environmental integrity, economic viability and a just society for present and future generations, while respecting cultural diversity" (UNESCO 2009). ESD embraces the crucial role that education plays in sustainable development. Until 1992, ESD was seen primarily as environmental education. With the 1992 UN Conference on Environment and Development (UNCED) in Rio de Janeiro and the Framework for Action of Agenda 21, ESD expanded and merged all forms of education, including environmental, social, ethical and cultural dimensions (UN 1992).

ESD achieved major recognition during the DESD, adopted by the UN General Assembly at its 57th session in 2002, with UNESCO designated as the lead agency for promotion throughout the following decade. It is important to mention that since 1992 UNCED has laid the basis for the UN Decade on ESD (Leal Filho 2015). In its "Future we want" document, the Rio+20 UN Conference on Sustainable Development in 2012 promoted the relevance of ESD beyond the ESD decade. "We resolve to promote education for sustainable development and to integrate sustainable development more actively into education beyond the Decade of Education for Sustainable Development" (UN 2012). Several Millennium Development Goals (MDGs) were related to ESD, which is considered to be an important instrument for organizations to achieve the MDGs (Wals and Kief 2010).

During the DESD, there were considerable efforts to integrate sustainable development into all aspects of learning, resulting in an increase in their appearance in national policies and international agreements. The importance of ESD for behaviour change for a sustainable future through engaging a wide range of stakeholders (from governments, the private sector, civil society, non-governmental organisations and the general public) was explicitly recognized (UNESCO 2014a).

At the end of the DESD, the Global Action Program (GAP) on ESD (2015-2019) was launched by UNESCO as an official follow-up, focusing in generating and scaling up actions

on the ground. This programme was based on five priority areas; advancing policy, transforming learning and training environments, building capacities of educators and trainers, mobilizing youth, and accelerating sustainable solutions at local levels as well as aiming to accelerate progress towards the SDGs (UNESCO 2014b). Currently, a framework created by UNESCO on ESD entitled “Education for Sustainable Development: Towards achieving the SDGs (ESD for 2030)” is in process. This framework was developed in order to build a post-GAP position that will contribute to the Agenda 2030 through: 1) continuation of support for ESD activities that contribute to SDGs, even without explicit reference, 2) communication and advocacy in educational settings with explicit reference to SDGs, and 3) ESD importance in addressing interlinkages between SDGs (UNESCO, 2019).

The core of ESD is the application in all levels of formal, non-formal and informal education as an integral part of lifelong learning. The International Standard Classification of Education defines formal education as what takes place in the education system of a country (either institutionalized, intentional and planned, through public organizations and recognized private bodies); Non-formal education is an alternative to formal education within the process of lifelong learning (guaranteeing the right of access for all without any formal recognition by the education authorities); on the other hand, Informal education is learning that is not institutionalized and less organized or structured than either formal or non-formal education, including learning activities that occur everywhere and in daily life, on a self or socially-directed basis (UIS 2012).

Nevertheless, ESD is a dynamic concept that contains crucial issues for sustainable development (such as climate change, biodiversity, sustainable production and consumption, and reduction of poverty) and relies on stakeholders to use education as an instrument to achieve sustainable development, and education stakeholders to integrate sustainability principles into education systems (UNESCO 2018b).

Different fields of education, such as environmental education, global education, economics education, development education, multicultural education, conservation education, outdoor education, global change education, among others, are complemented by education in sustainability (Leal Filho 2009).

Furthermore, ESD explores Global Citizenship for Sustainable Development (GCED), also included in Target 4.7. While ESD focuses more on environmental issues, GCED is more concerned with issues such as human rights, democracy, conflict and peace (<https://en.unesco.org/themes/gced/definition>). The concept of global citizenship in GCED is critical, calling for proactive engagement for sustainable development, compared to the softer

global citizenship component in ESD (Chung and Park 2016). ESD and Sustainability Science (SS) can be complementary. SS emphasises the scientific transition toward sustainability, while ESD orients the education system towards sustainability, both aiming for a systemic knowledge through inter- and transdisciplinary and multi-stakeholder approaches (Arico 2014). ESD can be complemented by other disciplines such as Citizens Science, which is the involvement of individuals in scientific processes (Kullenberg and Kasperowski 2016). While Citizens Science enables subject competence and empowerment of citizens (Pettibone et al. 2016) ESD encourages responsible choices and healthy lifestyles. ESD can foster sustainability transition, through the variety of stakeholders.

3.4 Methodology

This study is based on a comprehensive literature review, statistical analysis and analytical reflections by the authors. The data were collected through a survey conducted between April to July 2018, within the global network of 159 RCEs using a list-based sampling frame. The questionnaire was also published in the RCEs e-bulletin (Global RCE Network, 2018) and on the Facebook Page of the Global RCEs Network. The survey (supplemental information [SI] Table 5) was voluntary and anonymous and consisted of 25 questions divided into four sections. For the purpose of this study only questions 6, 7 and 8, of section 1 “RCEs and their involvement with the SDGs” were used, as they provided the relevant information and insights needed for the analyses of the current involvement of the RCEs with the 17 SDGs; Targets and Indicators in general and Targets of Goal 4 in particular. Data on the contribution of RCEs in the implementation of the 2030 Agenda was also collected during the survey and these findings have been published in a previous paper by the authors Shulla et al. (2019). The analysis of the results is divided into two sections.

Section (a) analyses the interactions of Target 4.7 with the most selected Goals by the RCEs. The purpose is to identify interconnections by illustrating the network representations. Descriptive statistics and Network Representation analyses were conducted with the support of software R (R. Core Team 2013).

Section (b) assesses the most influencing and influenced targets in the context of RCEs, by using the ‘Goal Interaction Scoring on a Seven-Point Scale’ framework; a typology and scoring of interaction as a conceptual basis for a science-based assessment (Table 1) (Nilsson et al. 2017; ICSU 2017).

Table 1. Goal Interaction Scoring on a Seven-Point Scale explained and labelled according to their interactions (Nilsson et al. 2017; ICSU 2017)

Interaction	Label	Explanation
+3	Indivisible	Progress on one target automatically delivers progress on another
+2	Reinforcing	Progress on one target makes it easier to make progress on another
+1	Enabling	Progress on one target creates conditions that enable progress on another
±0	Consistent	There is no significant link between two targets' progress
-1	Constraining	Progress on one target constrains the options for how to deliver on another
-2	Counteracting	Progress on one target makes it more difficult to make progress on another
-3	Cancelling	Progress on one target automatically leads to a negative impact on another

This framework allows the identification of the most positive or negative interactions, providing insights for the RCEs future actions and creating a basis for identification of common indicators applicable to a group of Goals. This framework is applied by using the cross-impact matrix at the Target's level, a methodological approach previously developed by Weitz et al. (2018). The weighting process is based on the author's judgement. To analyse and illustrate the network representations, specifically the relation of Target 4.7 with the rest of the targets of the matrix, further Network Representation analyses were conducted with the support of software R (R. Core Team 2013). Conclusions and findings were discussed using further literature reviews and authors reflections.

3.5 Results

There were a total of 31 replies to the survey, from the sample size of 159 RCEs. The response rate from the participants concerning the survey questions were: 100 % for the questions 6 and 8, and 42% for the question 7. The results are presented in two sections: a) The interaction of Target 4.7 with the 17 Goals in the context of the RCEs network, and b) Target interactions in the context of RCEs network.

a) The interaction of target 4.7 with 17 Goals in the context of RCEs network

This study identifies that the most used Goals by the RCEs are Goals 4, 13, 15, 7, 6, 12, 11 and 17. Table 2. shows the ranking of the SDG 4 Targets, identifying the use of the Target 4.7 by the majority of the respondents (84%).

Table 2. Involvement of the RCEs with the Targets of SDG 4, measured in numbers and percentage. (31 RCEs in total)

SDG4 Targets	Number of RCEs [%]
4.7 Education for sustainable development and global citizenship	26 [84%]
4.c Teachers and educators	17 [55%]
4.a Effective learning environments	14 [45%]
4.3 Equal access to technical/vocational and higher education	12 [39%]
4.5 Gender equality and inclusion	11 [35%]
4.1 Universal primary and secondary education	10 [32%]
4.4 Relevant skills for decent work	10 [32%]
4.6 Universal youth literacy	5 [16%]
4.2 Early childhood development and universal pre-primary education	4 [13%]
4.b Scholarships	1 [3%]

Further analysis based on the above information for the most used Goals and Targets are displayed in Figure 1, identifying the proportion of RCEs that use Target 4.7 in relation to the 17 Goals. The relation of Target 4.7 with the 17 SDGs is represented by a network plot, with target 4.7 at the centre. In the network plot, the width of an edge is proportional to the number of RCEs who use target 4.7 and the goal at the same time. The strongest links with Target 4.7 appears to be with the Goals 4, 13, 7, 11, 15 and 12. It illustrates the multidimensional aspects of ESD in relation to other Goals.

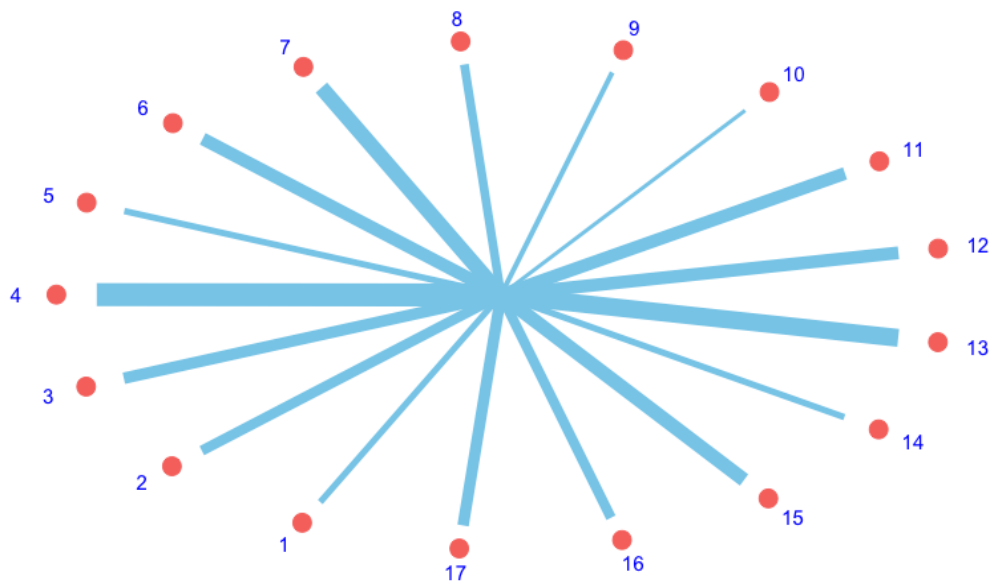


Fig. 1. The relation of Target 4.7 with the 17 SDGs. The strength or thickness of a link reflects the proportion of RCEs who use at the same time Target 4.7 and the respective Goals (Target 4.7 is positioned in the centre).

b) Target interactions in the context of RCEs network

There is insufficient information on the involvement of the RCEs that participated in this study with the SDGs Targets and Indicators. There was a relatively low response rate to survey question 7 (see SI, Table 4.) on their engagement with Targets and Indicators. Specifically, there is information only on their involvement with Targets and Indicators of Goal 4 (see Table 2). Nevertheless, analyses of Targets interactions in the RCEs context are crucial to establishing a common ground and coordinating actions for SDGs. For this reason, 27 Targets were selected based on the results of the most commonly used Goals by the RCEs, taking into consideration the focus and the field of expertise of the participating RCEs. The Targets were weighted based on the authors' judgement, using the "Goal Interaction Scoring on a Seven-Point Scale" framework. The values are displayed in the Targets Matrix in Figure 2. The matrix has a non-reciprocal character. The direction of the weighting is from the targets column to the targets row. The row of Target 4.7 is identified in bold to show the data used for further analyses. The overall scores horizontally show the total influence from a target to other targets. The overall scores vertically show how much a target is influenced by all targets in total. The weighting is based on the question: "If progress is made on target x (rows), how does this influence progress on target y (columns)" (Weitz et al. 2018). The higher the sum in the column the more positively the Target is influenced by other Targets. The higher the sum in the rows the more the Target positively influences other Targets. In general, Targets of Goal 17 and Goal 4 received the most points for positively influencing other Targets in the RCEs context.

An example which would illustrate this process would be if Target 4.c (row) "by 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States" progresses, it can positively influence Target 3.d (column) "Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks" due to the priority of teachers and educators in specific trainings outside the ordinary curricula in many RCEs projects.

The most influencing Targets (in rows) belonged to Goals 17, 12, 3, 4, 13, and 15, and the most influenced Targets (in columns) to Goals 17, 13, 12, and 11. Selected Indicators that belong to the most influenced and influencing Targets are summarised in Supplementary Information (SI) Table 5. A major part of these Indicators belong to Tier III, according to the

Tier Classification for Global SDG Indicators (UNDESA 2019), meaning that no internationally established methodology or standards are yet available, but will be developed. These Indicators can be considered by RCEs in order to redefine their objectives, or can be included in their impact evaluation frameworks. Although the explanations behind each weighting are not included in this study, Table 3 displays the scoring process for Target 4.7 toward other Targets. For this evaluation, we also considered flagship projects and best practices of RCEs across formal and informal educational sectors, cultivating participatory and change-oriented learning environments (UNU-IAS 2018a) and contribution to health and wellbeing for a sustainable future (UNU-IAS 2018b).

	2.3	2.4	3.7	3.d	4.3	4.7	4.a	4.c	6.6	6.b	7.a	7.3	11.3	11.4	11.6	12.1	12.6	12.8	12.b	13.1	13.3	15.5	15.c	17.6	17.14	17.16	17.17	
2.3		3	0	0	1	0	0	0	0	1	1	1	0	0	1	1	1	1	2	2	1	0	1	0	0	0	0	17
2.4	3		0	3	1	2	0	0	2	2	2	1	2	1	2	1	2	1	2	3	2	2	1	0	1	1	0	37
3.7	1	1		3	2	3	1	2	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1	1	1	20
3.d	0	0	3		1	2	2	2	0	3	0	0	1	0	2	0	1	2	1	1	1	0	0	1	2	1	0	26
4.3	2	2	2	3		3	1	1	1	1	1	1	1	1	1	0	1	2	1	1	1	1	1	0	1	0	0	30
4.7	2	2	3	3	2		1	3	1	1	1	1	1	1	1	0	1	3	1	1	2	1	1	0	0	0	0	33
4.a	0	0	0	0	0	2		2	0	0	2	2	0	0	0	0	0	1	0	0	1	1	0	0	1	0	0	12
4.c	1	1	2	3	2	2	2		1	1	0	0	1	1	1	1	0	2	1	1	2	1	1	0	1	0	0	28
6.6	0	1	0	0	1	1	1	1		1	1	1	2	3	2	1	0	1	1	2	1	3	3	2	1	1	1	31
6.b	1	1	1	2	2	2	1	1	2		1	1	2	2	2	1	1	2	1	1	2	2	1	1	2	0	0	35
7.a	1	2	0	1	3	3	2	1	2	1		3	1	0	2	1	1	1	1	1	2	3	1	1	2	2	2	40
7.3	2	2	0	0	1	1	1	1	2	0	3		1	1	2	1	2	1	1	1	1	2	1	0	0	0	0	27
11.3	1	2	2	2	1	1	2	1	2	3	1	2		3	3	1	1	1	2	2	1	2	0	0	3	0	3	42
11.4	1	2	1	0	1	1	1	1	1	2	0	0	2		1	0	1	2	2	1	2	2	2	0	2	0	2	30
11.6	1	2	0	3	1	1	2	1	3	3	2	2	2	2		1	2	1	2	2	2	2	1	1	3	2	2	46
12.1	2	2	1	2	1	2	2	1	1	1	2	2	2	2	2		2	2	1	2	2	2	1	2	3	3	2	47
12.6	2	2	1	1	2	1	1	1	1	2	3	1	2	2	1	2		1	1	2	1	2	1	2	2	1	1	39
12.8	2	2	3	3	3	3	1	2	2	2	1	2	2	2	1	1	1		2	1	3	2	1	1	3	2	1	49
12.b	3	3	1	2	1	2	1	2	2	1	1	2	2	2	1	1	1	2		2	2	3	2	0	3	2	3	47
13.1	2	2	1	3	2	3	2	2	2	2	2	2	2	2	3	2	2	2	1		3	2	1	2	3	2	2	54
13.3	2	2	2	3	3	3	3	3	2	2	1	2	2	2	2	2	2	3	1	3		2	1	1	3	2	2	56
15.5	1	2	0	1	1	1	1	1	3	2	1	1	1	3	2	1	1	2	2	1	2		2	1	3	1	1	38
15.c	2	2	1	2	2	2	1	1	3	2	0	1	1	3	1	1	2	2	2	1	1	3		3	2	3	2	46
17.6	2	2	2	2	3	1	1	1	2	2	2	2	2	2	3	2	2	2	1	2	2	2	2		2	3	3	52
17.14	2	2	3	2	3	3	2	2	3	3	2	3	3	2	2	3	3	3	2	3	3	2	2	1		2	3	64
17.16	2	2	2	2	2	2	1	2	2	2	3	3	2	2	2	3	2	2	2	3	2	1	3	3	2		3	57
17.17	2	2	2	2	2	2	3	2	2	3	3	2	3	2	2	3	3	3	3	2	3	2	1	3	3	3		63
	40	46	33	48	44	49	36	37	42	44	36	38	40	41	42	30	35	47	36	40	45	45	31	26	49	32	34	

Fig. 2. Matrix in Target level (27x27 Targets). Weighting is done in the direction from the Targets column which are the ‘Influencing Targets’ to the Targets row which are the ‘Influenced Targets’. Matrix is in Target level (Weitz et al. 2018) and weighting is done by Seven-Point Scale Goals interaction method (-3, Cancelling, makes it impossible to reach another goals), (-2 Counteracting, clashes with another goal), (-1, Constraining, limits option on another goal), (0, Consistent, no significant positive or negative interaction), (+1, Enabling, create conditions that further another goal), (+2, Reinforcing, aids the achievement of another goal), (+3, Indivisible, inextricably linked to the achievement of another goal) (Nilsson et al. 2016; ICSU 2017). The most eminent values are identified as -1 (red), neutral as 0 (pink), and +3 (blue).

Table 3. Explanations behind the scoring for the influence of the Target 4.7 (column) towards the 27 Targets (rows) as displayed in the Matrix in Figure 2.

Targets 4.7	Targets	Target Description	Evaluation n (-3-3 points)	Explanation
4.7 <i>By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through Education for Sustainable Development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and nonviolence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development".</i>	2.3	By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	2	RCEs partners are often farms or small enterprises related to food production. Several RCEs work with indigenous communities and women. It does not obtain the maximal points due to other factors such as access to the resources.
	2.4	By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	2	RCEs focus on traditional knowledge for food production systems and agricultural practices. They contribute to increase awareness through working with communities.
	3.7	By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes	3	The Targets are positively interrelated through the education component. RCEs contribute to awareness raising and information sharing about the issues of Target 3.7, with schools and communities. Furthermore, RCEs can work on reflecting these issues into school curricula's, as one of their objectives is to influence and orient school curricula toward sustainability.
	3.d	Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks	3	The RCEs make considerable contributions in influencing policies and increasing capacity strengthening related to the health issues.
	4.3	By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university	2	RCE work is focused on different levels of education, including vocational training. But the access of women and men also depend on other factors.
	4.7		1	
	4.a	Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all	1	Examples from RCEs projects indicate for an integrated approach in projects related to schools and education, e.g. raising awareness for effective learning environments, by introducing and implementing measures for reducing their environmental footprints. https://edufootprint.interreg-med.eu/news-events/news/detail/actualites/green-schools-sixth-edition/ .
	4.c	Teachers and educators	3	Priority for teachers' and educators' specific training in sustainability issues outside the official curricula, e.g. the RCEs Opeduca project with schools (https://www.opeduca.eu/The_OPEDUCA_Project.html).

6.6	By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	1	Contribute to the awareness raising (individual and institutional) for the importance of the issues.
6.b	Support and strengthen the participation of local communities in improving water and sanitation management	1	The Target implementation depends more on the will of governments for inclusion of the communities. The potential contribution is related to the awareness raising for the bottom-up involvement.
7.2	By 2030, increase substantially the share of renewable energy in the global energy mix	1	Contribution to the educational aspect of energy efficiency and energy use.
7.3	By 2030, double the global rate of improvement in energy efficiency	1	Contribution to the educational aspect of energy efficiency and energy use.
11.3	By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.	1	The Target implementation depends more on the will of governments for inclusion of the communities. The potential contribution is related to the awareness raising for the bottom-up involvement.
11.4	Strengthen efforts to protect and safeguard the world's cultural and natural heritage	1	The potential contribution is related to the awareness raising for the bottom-up involvement.
11.6	By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	1	The potential contribution is related to the awareness raising at individual and organization level.
12.1	Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries	0	Although RCEs work on issues of Consumption and Production, the implementation of the Target depends more on the national level.
12.6	Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle	1	RCEs can influence partners from the business sectors, though they consist mainly of small and medium enterprises.
12.8	By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	3	Target 4.7 contributes directly to the implementation of this Target. RCEs work with communities everywhere in the world contribute to increase awareness and provide information for these issues.
12.b	Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products	1	Many RCEs work in sustainable tourism and promotion of local culture, e.g. Sustainability Learning and Ecotourism (UNU-IAS, 2018c); yet the Target depends more on government approaches.

13.1	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	1	Requires a national approach but the contribution can be in the educational component of the individuals and organizations.
13.3	Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	1	The related RCEs projects can contribute to capacity strengthening and awareness raising.
15.5	Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species	1	Contribution is related to the educational aspect. Although the Target timeframe is 2020 the measures required depend more on national actions.
15.c	Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities	1	RCEs contributions are related to the increase of capacities of local communities to pursue sustainable livelihood opportunities.
17.6	Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge-sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism	0	The exchanges within the RCEs network at the global level can contribute to knowledge exchange and sharing within the world regions. Projects and activities of RCEs are shared at the RCEs network platform. Innovative actions can be disseminated or applied to other regions. . These actions, although often modest in scope and size, and informal, contribute to the international cooperation as explained in the Target 17.6.
17.14	Enhance policy coherence for sustainable development	0	Although the RCEs aim to influence sustainable development policies they depend on the government actions.
17.16	Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries	0	The partnerships are at the core of the RCEs, but they are at local scale. Target 4.7 can contribute to awareness raising for the importance of these partnerships, for instance through research.
17.17	Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships.	0	RCEs promote effective partnerships though ESD, which can be of multi-stakeholders but not necessary involving public institutions. The Indicator 17.17.1 “Amount of United States dollars committed to public-private and civil society partnership” appears to measure initiatives funded by public institutions.

Figure 3. further visualises results from the Targets matrix in Figure 2. and illustrates the interconnection of Target 4.7 with the rest of the selected Targets. The network plot identifies the strength of the links between the different targets based on the calculation of data displayed in the relationship matrix in Figure 2. Target 4.7 is positioned at the center. The width of each edge reflects the strength of the positive influence of Target 4.7 with the other Targets. The strongest interconnection appears to be with Targets 4.8, 4.c, 3.d, 3.7, 2.4, 2.3, 12.8, 12.b, and 15.5

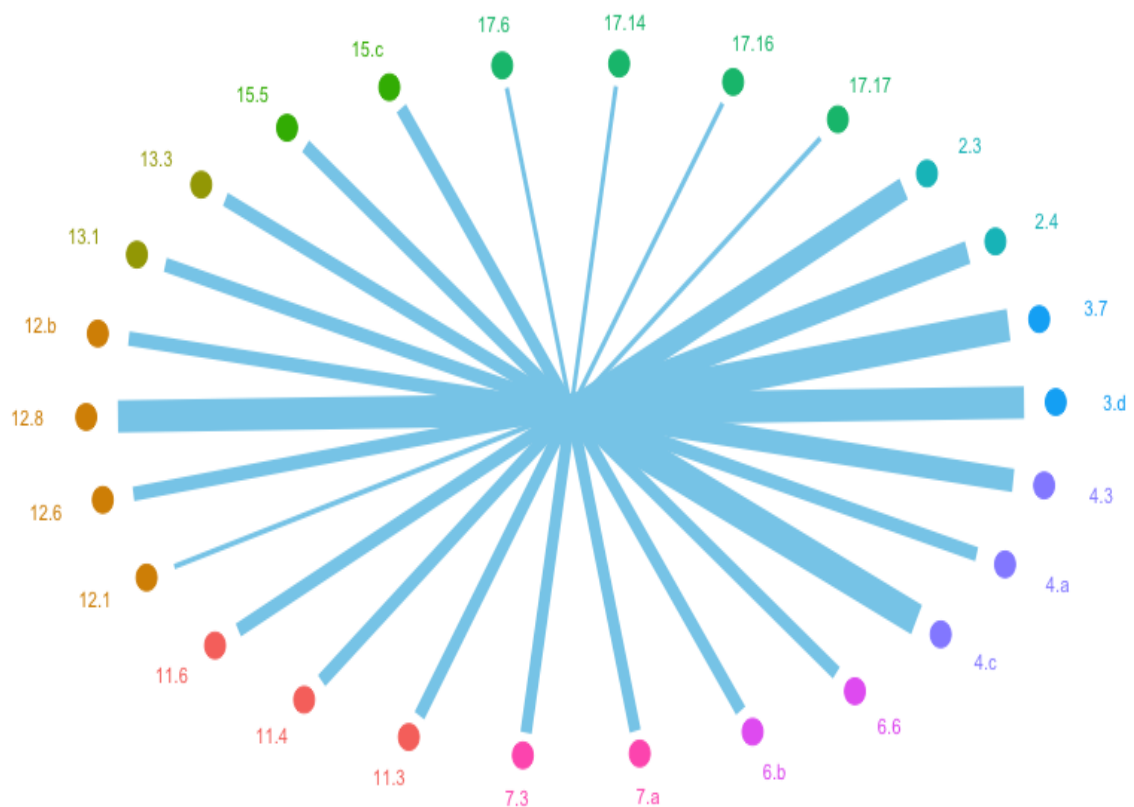


Fig. 3. Network representation of the links of Target 4.7 with other targets. The network plot identify the strength of the links between the different targets based on the calculation of the data as displayed in the relationship matrix in Figure 2. Target 4.7 is positioned at the centre. The width of each edge reflects the strength of the positive influence of Target 4.7 with the other Targets.

3.6 Conclusions and Discussion

ESD is a dynamic concept that includes all actions and challenges towards sustainable development, and is at the core of global goals for a sustainable future. RCEs multi-stakeholder global networks are adopting their strategies and working programs according to the 2030 Agenda, through the prioritization of relevant SDG thematic areas and translating them into regional contexts through ESD, such as education, climate, energy, sustainable cities, natural habitat and responsible consumption and production (Shulla et al. 2019).

This study substantially contributes to research on the approach of ESD toward the 2030 Agenda for Sustainable Development. It particularly addresses the implications of Target 4.7 on the 17 SDGs, based on the evidence of the current actions of multi-stakeholder SDG networks. In addition, it highlights research gaps for the interactions between SDGs Targets in specific contexts. We identified a list of SDGs Targets with positive interdependence, indicating the strongest components of ESD in relation to emerging global issues. This should be considered in future planning and strategies by RCEs and similar networks and organisations.

We suggest the strongest elements for the RCEs approach toward the 2030 Agenda through ESD, such as 1) partnerships, 2) informal learning and 3) thematic focus.

- 1) **Partnerships:** Partnerships for sustainable development are considered crucial to the implementation of the SDGs, as it is explicitly expressed in Goal 17. In fact, several targets of SDG 17 are among the most influencing and influenced Targets in the RCEs context (see SI Table 5). ESD has served as a connecting element for partnerships through the work of RCEs since 2005. Mainstreaming ESD in the framework of 2030 Agenda can contribute to network-building amongst the network partners, such as civil society, business, academia, communities, and local governments. The network partnerships may continue to be a priority in the post-Gap “ESD for 2030 approach” (UNESCO 2019) and partnerships for ESD and multi-stakeholder co-learning are related to the implementation of ESD in all levels of governance (Wals et al. 2017).
- 2) **Informal learning:** The analyses of the potential Targets influences (see Table 3) (also identified informal learning component of ESD) is strongly reflected in the RCEs

work with communities, which in the light of the 2030 Agenda can add a substantial contribution to their approach towards the SDGs. The impact of informal learning is often invisible and difficult to measure. There is also insufficient research for the informal component of ESD, this is due to the fact that it is mainly promoted through formal education, neglecting the informal education connection with community development (Noguchi 2015).

- 3) Thematic focus: ESD's orientation toward several SDGs thematic issues would require RCEs around the world to align their focus and local agendas to the current sustainability challenges. RCEs worldwide involvement with SDGs, using their unique approach through ESD, can facilitate a further integration of ESD into the SDGs framework. Identifying and understanding the sustainability issues, prominent now and in the future, remain crucial aspects of ESD (Lambrechts and Hindson 2016). Grouping the SDGs Targets and Indicators based on the analyses of their strongest interactions, as displayed in Table 5, can help to avoid divisions during the implementation process. Encouraging organizations and networks that work on local solutions through ESD to integrate and align their programs with the SDGs framework can contribute to a clear reflection and understanding of the current sustainability challenges, and can avoid separate agendas, therefore allowing for an integrated approach toward the 2030 Agenda for Sustainable Development. At Target level (Figure 3.), this study shows a strong link between Target 4.7 and Targets 2.3, 2.4, 3.7, and 3.d, revealing additional components of ESD relevant to the SDGs thematic issues of Goal 3 "health" and Goal 2 "hunger", which were not evident from the analyses at Goal level (Figure 1). While the analysis at Goals level was based on data collected from the RCE survey, the analyses at Targets level resulted from data generated from the Targets Matrix (see Figure 2).

Altogether, it is challenging to shape non-formal education related to sustainability issues, especially for adults. Nevertheless, this can be achieved through information campaigns and job training (UNU-IAS 2016). The complexities of climate change education can be fully addressed by ESD components (MoChizuki and Bryan 2015). The sustainability debate has recently gained momentum and public attention. The "Fridays for Future movement" of students campaigning for immediate action on climate change, for example, has fuelled the global conversation

<https://www.unenvironment.org/championsofearth/laureates/2019/fridays-future-movement>.

This offers an opportunity to weave ESD concepts into mainstream society at many different levels and may even push governments towards the implementation of meaningful policies which address and implement the 2030 Agenda for Sustainable Development in a credible manner.

3.6.1 Limitations of the study and implications for theory and practise

There are some limitations related to this study, such as the relatively small sample size of the RCE survey. Greater participation from the RCEs community would have allowed for a deeper analysis. Consequently, information on the RCEs involvement with specific Targets and Indicators was limited. The weighting process for Target interactions is context dependent, and was influenced by the judgement of the authors. Lastly, the study does not consider the possible negative influences of contradicting Targets, and their potential implications for the role of ESD in the 2030 Agenda.

This study contributes to research on the approach of ESD toward the 2030 Agenda for Sustainable Development. It particularly addresses the implications of Target 4.7 on the 17 SDGs, based on the evidence of the current actions of multi-stakeholder networks. In addition, it highlights research gaps for the interactions between SDGs Targets in specific contexts.

Finally, the study identifies a list of SDGs Targets with positive interdependence, indicating the strongest components of ESD in relation to emerging global issues; this should be considered in future planning and strategies by RCEs and similar networks and organisations.

4. Channels of collaboration for Citizen Science and the Sustainable Development Goals

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4.1 Abstract

Citizen Science, known as the participation of individuals and groups in scientific processes, is an increasingly growing discipline, which can contribute for the achievement of the Sustainable Development Goals. The UN Agenda 2030 for Sustainable Development is all-inclusive, where every contribution is valid. Participation, partnerships, education, sustainable living and global citizenship, all of which can build on Citizen Science activities, are crucial for the Sustainable Development Goals. In this context, this study aims at exploring several collaboration channels for Citizen Science-related activities and the Agenda 2030. Challenges and critical aspects are discussed based on the opinions of practitioners collected through a comprehensive online survey. Furthermore, recommendations for future involvement are given on a framework of interactions at different levels for Citizen Science and the Agenda 2030.

4.2 Introducing Citizen Science

Citizen Science (CS) works alongside science, education, and civic engagement and is increasingly being a discipline in its own right (Science Europe, 2018). There are several definitions, but CS is often considered as the participation of lay people, individuals, or groups in scientific processes (Kullenberg and Kasperowski, 2016). These contributions differ from informal learning due to engagement in science-related processes (Jordan 2002), such as modelling, new discoveries, observations, data collections and analyses, technological processes, and evidence-based policies (Raddick et al., 2009).

Citizen Science has existed for a long time, but it has especially expanded in recent years due to more collaborations between volunteers and researchers, emerging technologies and new ways of data collection such as crowdsourcing, digital sharing, online projects and social networks (Socientize, 2013). Common synonyms for CS are "amateur science," "crowd sourced science," "volunteer monitoring," and "public participation in scientific research" (<https://scistarter.org/citizen-science>).

A citizen scientist, without necessarily a scientific background, volunteers to collect or process data for scientific research (Silvertown 2009). CS has changed the professional-amateur relationship because of an increased accessibility to the internet and tolerance of the web (Dowthwaite and Sprinks, 2019). The field of CS is growing towards scientific literature and policy making, but there is a need to foster trust in CS results, so to increase their use and consequently strengthen the field (Rasmussen, 2019). Barriers to the implementation of CS projects, either practical (lack of funding or training) or theoretical (whether the projects live up to the standards of scientific practice) are context dependent without necessarily reducing results quality (Elliott and Rosenberg, 2019). CS is more successful in some fields than in others. For instance, in soil science or ecosystem ecology, although it facilitates conservation, technical expertise and samples quality are perceived as obstacles (Reed et al. 2018). Capacity building processes for CS can be important for future policies, but necessitate the involvement of wide range of people and institutions (Richter et al., 2018). Citizen Science is implemented mainly in industrialized countries such as the US, European nations and Australia (Guerrini 2019), and it is increasingly witnessed in China as well as in the Global South. CS is less visible in developing countries (Pocock 2018), challenged by accountability, data accuracy, lack of trust, and specific cultural issues among others. Despite that, CS has potential for developing countries, as it facilitates long-term datasets and monitoring (Gouraguine et al., 2019).

4.3 Citizen Science and the Sustainable Development Goals

Several features of the UN Agenda 2030 for Sustainable Development can build on Citizen Science, such as encouraging participation, partnerships and collaborations, education, sustainable living and global citizenship. CS related activities can address sustainability challenges and contribute to the implementation of Sustainable Development Goals (SDGs). Citizen Science encourages social cohesion, a crucial element for the moral dimension of the Agenda 2030, which aspires to benefit all people and leave no one behind through global citizenship and shared responsibility (UN 2015). The Agenda 2030 document assigns the principal obligation to the member states, depending on their capacity and political will. The role of non-state actors and individuals during the SDGs implementation process is ambiguous, affected by national actions (Bexell and Jönsson, 2017).

Sustainable development does not require a top-down approach, but rather a networked, problem-solving attitude, where all actors, and especially young people, are engaged (Sachs, 2012). It is widely accepted that the implementation of the SDGs requires a full integration across sectors, disciplines, countries, and actors. Explicitly in Goal 17, “Partnerships for the Goals,” the role of non-state actors in multi-stakeholder partnerships is emphasized as a way to engage with and enhance cooperation (UN, 2015). Furthermore, in order to use the SDGs as a “common language,” it is necessary to scale them down to all levels of society such as individuals, communities, organization, networks etc. For sustainable development, public participation is crucial (Leal Filho, 2019). As a consequence, CS actions performed by individuals, teams, or networks of volunteers with a significant contribution to the societal changes cannot be neglected. Citizen Science can contribute to attaining the SDGs by pressuring governments and businesses to take action, through defining national priorities, monitoring, and implementing processes (West and Pateman, 2017).

The role of CS for the SDGs is acknowledged by the United Nations institutions through the “Citizen Science Global Partnership” (CSGP), launched in December, 2017. This network seeks to promote CS for a sustainable world and to support existing CS associations such as the European Citizen Science Association (ECSA), the US Citizen Science Association (CSA), the Australian Citizen Science Association (ACSA) and other emerging networks. Its purpose is to coordinate NGOs, governments and businesses that work with the global CS community and to track the contributions of CS towards the SDGs implementation (<http://citizenscienceglobal.org>). Furthermore, a task group “Citizen Science for the SDGs - Aligning Citizen Science outcomes to the UN Sustainable Development Goals” was established in order to facilitate and encourage the inclusion of data generated by Citizen Science projects in the official framework to monitor the SDGs (<http://www.codata.org/task-groups/citizen-science-for-the-sustainable-development-goals>).

Citizen Science actions or processes can drive society transformations (Chari, 2017). To achieve a sustainable transition of societies, it is mandatory to prioritize the citizens’ concerns and to appreciate their knowledge (Wildschut, 2017). Citizen Science can advance a better understanding of science as a whole (NACSEM, 2018). The movement is driving the necessity for transparent processes and access to science (Irwin, 2018). The benefits of researchers are related mainly to research quality, dissemination and science appreciation in the future (Knack et al. 2017). Citizen Science actions reduce mistrust through collaborations and orient science to react according to the necessities of the society (Smith et al. 2017). Citizen Science can also advance a better understanding of the Agenda 2030. The

engagement of scientists in the SDGs' by fostering evidence based policymaking by the UN Institutions would result in a stronger process of policy design and implementation (Elliott et al., 2019). Furthermore, the SDGs are an opportunity to revive the sustainability research agenda, due to the importance of sustainable development principles for policies and quality of life (Leal Filho et al, 2018). In order to contribute to sustainable development, individuals must understand the ambiguous and complex issues of sustainability and become "sustainability citizens" (UNESCO, 2018). Some elements that influence CS as it is related to sustainability are innovation, citizenship, ethics, education and knowledge. The Agenda 2030 debate on the goals can be informal for a wider non-specialist public, thus raising the world population's awareness about the urgency for sustainability challenges (Josephsen, 2017).

This study considers theories of governance and partnerships for sustainable development. Governance facilitates the political dimensions of CS, showing its impact outside the government and policy aspects (Gobel et al. 2019). For progress towards sustainability, governance structures should enable coordination in uncertain and complex environments with multiple actors at all levels (Kemp et al., 2005). Complementary, to empower citizens to inform decision making a combination of social and technological innovation is needed (Groom et al 2019). Governance of a CS project is also important to explain how much it contributes to the SDGs. Unlike social enterprises, CS projects are based on operational rather than business models (Bio Innovation Service, 2018). Citizen Science processes can take place on a global level, as virtual, huge interactions, or on a local level as more continuous, hands-on interventions (Socientize, 2014). Social or governance frameworks usually define the position of CS at governance level, in the process of linking institutions with citizens (DITOS 2019b). CS challenges in policy are related to issues of data quality and management, governance and policy implementation (Hecker et al, 2019).

There are many visible and invisible ways in which individuals, groups, or organizations can influence the SDGs. This study considers five collaboration channels of CS, as presented in Table 1. These channels will be useful throughout the paper.

Table 1. Collaboration channels of Citizen Science

<p>a) Influence through the representation of organized Citizen Science networks in the multi-stakeholder partnerships and engagement mechanisms created for the SDGs, at the national and international level</p>	<p>Goal 17 explicitly stresses the importance of alliances for the SDGs and encourages non-state actors' involvement in the multi-stakeholder platforms. The communities engaged in CS are getting better organized, but the contribution to the SDGs through the multi-stakeholder platforms depends on many factors such as the degree of institutionalization in each country, the infrastructure of involvement, and the willingness of national institutions to collaborate with CS organized groups or networks.</p>
<p>b) Influence through contribution to each of the SDGs individually, by actions that contribute to addressing sustainability issues and themes, i.e. nature conservation, climate change, health, etc.</p>	<p>Although environmental contribution is considered a strong point for CS, tackling sustainability can depend on outreach to society through project structure and governance. Usually, CS projects, even small, cannot reach all layers of society for instance citizens with a tertiary education (Hecker et al. 2018).</p>
<p>c) Influence through involvement in the policy cycle</p>	<p>Citizen Science contribution in policy processes enhances science, society interactions and evidence-based policies. Yet, its impact is difficult to track due to the policy cyclic features and the space of scientific evidence for decision making (Bio Innovation Service, 2018). The Agenda 2030 addresses public participation in many targets, i.e. <i>Target 11.3, by 2030, enhance inclusive and sustainable organization and capacity for participatory, integrated and sustainable human settlements planning and management in all countries</i>. The integration of Citizen Science into policy remains challenging, because CS projects achieve multiple outcomes and contribute to different fields (Haklay et al., 2018).</p>
<p>d) Influence through education</p>	<p>Citizen Science contributes to the citizens' empowerment by subject competency and education. It complements Education for Sustainable Development (Pettibone et al., 2016), and Global Citizenship, embraced in the Agenda 2030 in Targets 4.7, 12.8, 13.3. Citizen Science can address Goal 4 in quality education by being included in the curricula, as an educational tool that combines non-traditional and traditional learning (DITOS, 2019a). While in relation to civic education, it fosters a broad scientific mentality, encouraging democratic engagement and addressing complex modern problems (Ceccaroni, 2017).</p>
<p>e) Influence through the SDGs' monitoring and reporting, as a source for data provision</p>	<p>The complicated process of the SDGs' data management and monitoring requires additional sources of data provision. Data provided by CS-related activities can be valuable for the national statistical offices or the UN Statistical Office, i.e. as a non-traditional data source. Citizen Science is also acknowledged as a complementary source by policymakers for environmental policies, environmental monitoring and reporting, especially valuable for early warnings of environmental issues (European Commission, 2017).</p>

The objective of the study is to explore several “collaboration channels” for Citizen Science and the Agenda 2030 for Sustainable Development, by analysing challenges and critical aspects, and by providing a framework of interaction from the top-down and bottom-up perspective in order to encourage a broader and more effective engagement. The analyses are based on information from the current practices and opinions of practitioners, researchers, scientists, policy makers, citizen scientists, and organizations that involve citizens in scientific projects, and representatives of CS networks.

4.4 Methodology

In order to provide a better understanding of the contribution of CS to the implementation of the SDGs, an international survey was performed. At first, a list of topics of interest was developed and reviewed by the authors, aiming to ensure that all pertinent questions were considered and to remove potential overlaps among them. The survey was then disseminated using the online application Google Forms, and responses were collected between March and July 2019. The survey was composed of 11 questions encompassing the “collaboration channels” (a), (b), (c), (d), and (e), as displayed in Appendix 1, including the respondents’ role in CS, forms of engagement in CS-related activities, forms of participation in the SDGs’ processes, and, in particular, the involvement with each Goal. Furthermore, questions about the motivation for CS to contribute to the SDGs, critical points, challenges and opportunities were also assessed.

The survey was designed to collect data from a wide audience, including practitioners from diverse disciplines, citizen scientists, policy makers and researchers. The authors disseminated the survey by email to the network of the Citizen Science COST Action and to other networks or CS national or international platforms and projects, as presented in Appendix 2. Furthermore, the office of Inter-University Sustainable Development Research Programme (IUSDRP), (<https://www.haw-hamburg.de/en/ftz-nk/programmes/iusdrp.html>), disseminated the survey by email to the researchers connected to IUSDRP. As stated in the introductory note about the survey, knowledge about Citizen Science was fundamental for participation, as respondents were to express their opinions based on their personal experience. The survey was also applied (and disseminated to the participants) during two workshops organized by the COST Action CA15212: 1) Workshop of WG4 and EU-Citizen Science: co-creating the European Citizen Science platform of the future and the 2) Workshop of WG5, on citizen-science ontology, standards and data.

The survey results were analysed through simple descriptive statistics in order to summarize and combine the collected information. Quotes from open spaces were used to support the results, presenting real and practical experiences/concerns from the respondents. These responses were investigated through content analyses and its inductive approach – in which the organisation of responses includes open coding, creation of categories, and abstraction (Elo & Kyngäs, 2008).

4.5 Results

This section presents an overview of the survey findings, related to the respondents' countries and role to CS, their contribution to the SDGs, the processes of implementation, motivation and challenges. The survey received 84 responses in total and the respondents were based mainly in Europe (73%, n=61). The demographic distribution of the participants is detailed in Figure 1. It can be observed that approximately 21% of the respondents are from other continents and some of them (presented as “Anonymous”) opted for not stating their countries.

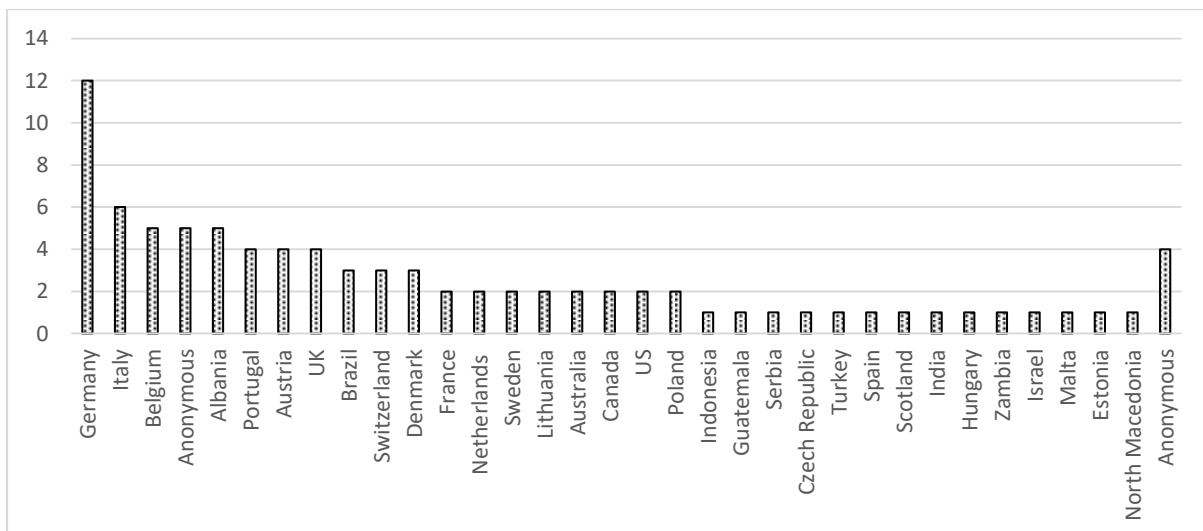


Fig. 1. Location of the 84 respondents and number of responses per country

The majority of the respondents are part of organisations that involve citizens in scientific projects/initiatives or belong to the CS national/international networks. The percentages of respondents according to their role in CS are shown in Figure 2. Some participants who selected the option “Other” belong to organizations that coordinate CS projects, or are game creators or providers of data collection infrastructure for Citizen Science.

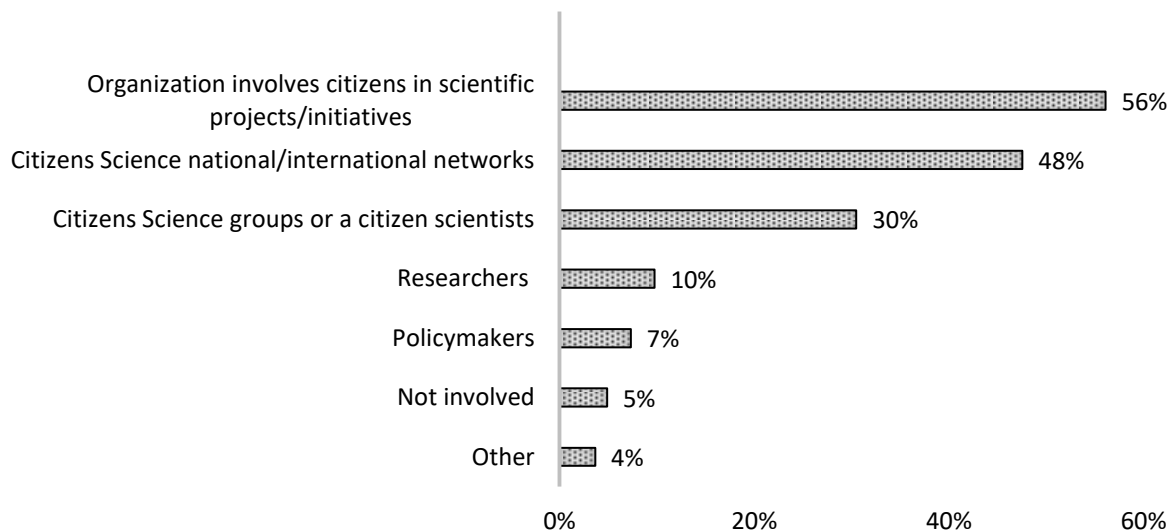


Fig. 2. Group of respondents according to their role in CS (% , n = 84)

The gathered responses show that some efforts are already in motion to align the CS-related activities with the Agenda 2030 for Sustainable Development. While 31% of respondents stated that they are integrating the SDGs in existing CS projects or research and 25% are in the process of aligning policies with the goals, 12% indicated not having started this process. Most of the participants (60%), on the other hand, declared that they are working broadly on SDGs themes (i.e. health, water, biodiversity, education), which contributes indirectly to achieving the goals. The participants mentioned additional specific information about their involvement, as illustrated in the quotes in Table 2. In some cases, respondents also mentioned to be working with specific targets of some SDGs.

Table 2. Quotes presenting additional information on the alignment between CS and the SDGs

Main aspect	Quotes
SDGs and CS integration	<i>"A section for SDGs is being included in work for the preparation of the Ontology of CS, by Working Group 5, of COST Action CA15212".</i>
Align policies with SDGs	<i>"Our infrastructure implements standards-based data and metadata capture which should allow for citizen science data to be more readily used in data analysis for SDGs".</i> <i>"ECSA is part of CSGP which is working to link CS with SDGs".</i>
Work with specific Targets	<i>"Including citizens to record data to map invasive alien species, it aligns with target 15.8 "By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species" and indirectly with other SDGs in terms of increasing awareness on environmental issues, and increasing scientific literacy".</i>
Research	<i>"In my PhD research I linked CS with the notion of the "commons" that is with the idea of sustainability and accessibility"</i> <i>"I research if and how policy making guidelines such as Agenda 2030 are "done"/practiced during CS activities connected to museum public engagement".</i>

Regarding respondents' work with specific Sustainable Development Goals, Figure 3 presents a ranking from the most to the less used SDG. Goals 4 (Quality Education), 11 (Sustainable Cities and Communities) and 13 (Climate Action) were the most selected ones, following the same trend presented by Salvia et al. (2019).

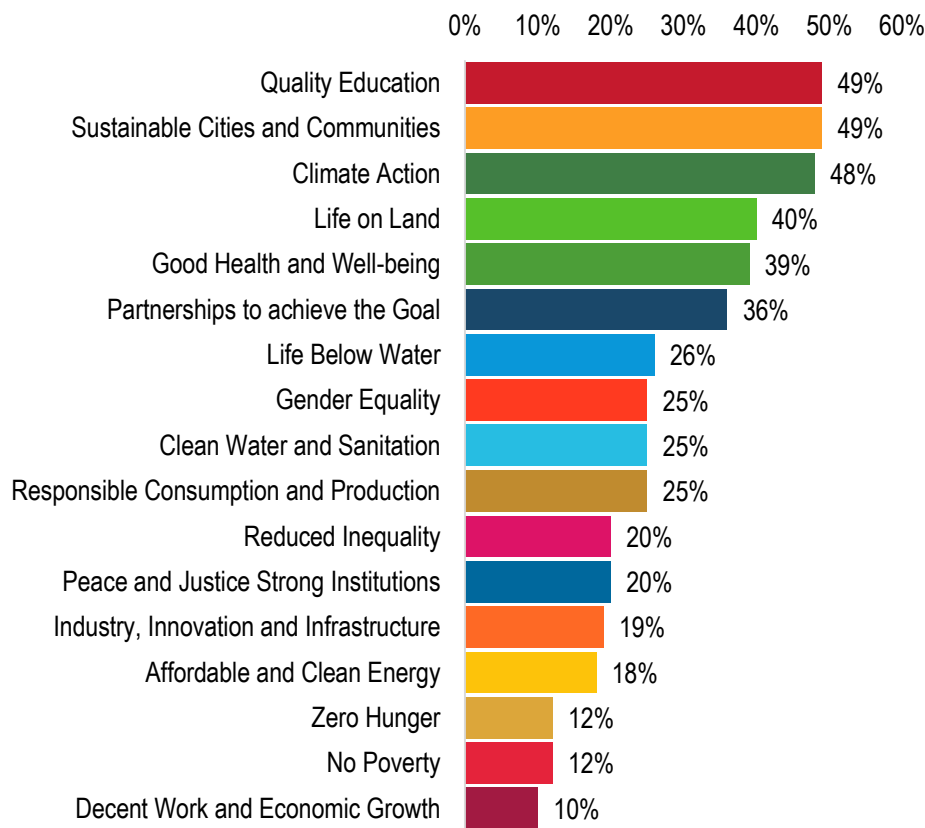


Fig. 3. Ranking of the most used SDGs by the survey respondents

When it comes to the goals prioritised by countries with higher number of respondents, there are some interesting differences. For Germany, the goals are 4, 5, 11, 12, and 13; Italy has SDGs 13, 15, and 17; Belgium has the goals 2, 7, 11, and 12; and finally but not least: Albania, with SDGs 10, 11. These topics tend to be related to the strengths and weaknesses of each region (Salvia et al., 2019), therefore being more researched by CS as well.

The respondents of this survey participate in the SDGs implementation processes through creation of partnerships or collaborating with existing networks (32%), and through actions organized by national/local entities or by international organizations (29%). Furthermore, 30% of them invite CS groups or networks in national/local initiatives, i.e. to participate in public consultations and expert workshops. 23% of the respondents are not participating in

SDGs related processes. Other forms of participation, mentioned by 13% of the respondents, mainly related to dissemination and engagement, are shown in the quotes in Table 3:

Table 3. Quotes presenting additional forms of participation in SDGs processes

Main aspect	Quotes
Support in implementing actions related to the SDGs	<p><i>"We support scholars to implement projects that feature SDGs, including teachers and students".</i></p> <p><i>"We shape the projects we implement and some of these are actively engaging with SDGs".</i></p> <p><i>"By considering SDGs in the new EU Common Agricultural Policy indicators".</i></p>
Promoting awareness and local actions	<p><i>"By letting citizens address their own concern, with small action all around the globe for fixing local issues can help fixing global issues".</i></p> <p><i>"Awareness raising, simulation of local action".</i></p> <p><i>"By empowering citizens so they can address SDGs".</i></p>
International efforts	<p><i>"Contributing to international efforts on data and metadata standardisation and data mobilisation to data aggregators".</i></p> <p><i>"Integration into curriculum (K-12 and Higher Education) and weave into community science, including the global City Nature Challenge".</i></p>

Providing general data to fill the gaps of information for the 17 Goals is considered very important by 69% of the respondents, while 45% of them find it more useful to concentrate on the data for the environmental indicators. 48% consider it important to channel the data through national reporting and monitoring platforms and 30% through UN statistical offices. Other forms of data provision, selected by 13% of respondents are explained in the quotes in Table 4:

Table 4. Quotes presenting additional forms of data provision

Main aspect	Quotes
National reporting	<p><i>"I find it important, through the national reporting and monitoring platforms because I think the data could certainly contribute to that, although I have no knowledge of those platforms in my country; however, CS data are already widely in use for meeting environmental reporting obligations".</i></p> <p><i>"Provide insight into the actual perception and penetration of SDGs in various sectors".</i></p>
Disaggregation	<p><i>"By establishing new indicators for those SDGs that don't have a specific indicator yet".</i></p> <p><i>"CS data serve not only for filling gaps but also adding complementary views".</i></p> <p><i>"There is scope for CS to not just provide data, but also raise awareness of the challenges".</i></p>
Non official channels	<p><i>"Through community non official data that can be contrasted with national environmental data".</i></p> <p><i>"By involving communities in their own implementation of SDGs, creating models for development of SDGs and understanding current bottle necks in some developments from a social perspective so that they can be efficiently tackled".</i></p>

Regarding the elements of the Agenda 2030 which can engage the cooperation of Citizen Science, the expressed opinions were also balanced: 61% of the responses pointed out the Educational element (including sustainable living and global citizenship); 56% highlighted the importance of Collaboration and partnerships; and 54% of the responses identified the participatory character of the Agenda 2030 as significant for CS efforts. Additional elements mentioned by the respondents are explained in the aspects and quotes of Table 5:

Table 5. Quotes presenting additional opinions about the important elements of the Agenda 2030 for CS

Main aspect	Quotes
Institutionalization	<p><i>“Specific clarity and guidance around where gaps in SDG knowledge/data exist and clear project ideas, methods and protocols for community participation. It is critical that participatory projects be driven/promoted with a strong and simple goal focus and be well supported”.</i></p> <p><i>“There is no actual enforcement”</i></p> <p><i>“I think that CS and SDGs are very close, regardless of the recent label SDGs”.</i></p> <p><i>“CS and policymakers need to work in partnership or else the citizens will just do their own thing. They are not just a cheap labour force without their own agenda. Much can be achieved with CS, but it is not a panacea for the world's problems”.</i></p>
Specific Goals	<p><i>“Promoting gender equality and social inequalities”.</i></p> <p><i>“Specific Goals, such as SDG4, SDG5, and SDG17”.</i></p>
Education and values	<p><i>“CS is a great way to teach science with plenty of added value. It should be integrated into schools’ curricula”.</i></p> <p><i>“Linking to the SDGs is essential for CS. It will support efforts to achieve the SDGs, but more importantly it will raise CS awareness for SDGs, and progress toward them”.</i></p>

Regarding some of the challenges or obstacles that prevent CS from engaging with the SDGs, the lack of awareness for SDGs is the most considered by 64% of the respondents. Other problems are related to the lack of infrastructure of involvement (55%), data reliability, accuracy and ownership (38%), exclusiveness of CS related activities by institutions (36%), and the voluntary character of CS contributions by 33% of respondents. Other problems stated by 16% of participants include the information explained in the quotes in Table 6:

Table 6. Quotes presenting additional challenges that prevent CS in engaging with SDGs

Main aspect	Quotes
Political and institutional aspect	<p><i>“SDGs are a political tool, not sure if the citizens need to work with it”.</i></p> <p><i>“To achieve something they believe in, politics make a link and ‘box’ it into SDGs Square”.</i></p> <p><i>“The Goals are for policymakers, they are not for citizens”.</i></p> <p><i>“CS projects could not be interested in policy making activity and prefer to focus on the local/community level without scaling up to global/institutional level”.</i></p> <p><i>“Low credibility of official entities which promote SDGs, often hypocrite and/or using double standard”</i></p> <p><i>“Lack of capacity of National Statistical Offices to handle non-traditional data, their resistance to new data sources, data quality issues, etc.”.</i></p>
Resources	<p><i>“Lack of funding from the National Statistics Offices and related public bodies”.</i></p> <p><i>“For statistical offices, CS data is perceived to lack representativeness, too much”.</i></p>

	<i>bias</i> ".
	<i>"Financing opportunities for long-term CS projects"</i> .
SDGs aspects	<i>"Intrinsic contradictions/ target conflicts"</i> . <i>"For indicators at global level, CS data has not the right coverage"</i> . <i>"The lack of guaranteed delivery in the future"</i> . <i>"Should be transparent the communication of SDGs"</i> .
Educational institutions challenges	<i>"Academic reward schemes, deficit models in public engagement"</i> . <i>"Pressure on school curricula, they may not feel they have space on SDGs"</i> . <i>"Institutional mechanisms at higher education institutions supporting CS"</i>
CS limits	<i>"The term CS is very confusing, it's very broad and covers many definitions, and maybe it could be good to fix that first"</i> .

Reasons for the motivation of individuals, groups or organizations involved in CS activities to contribute to the SDGs are very diverse. "Recognition" is the most selected reason (54%), followed by "possibilities for new partnerships" (48%), and "financing opportunities" (38%). Additional reasons stated by 29% of respondents include added value, peer pressure, ideology and responsibility, as shown in this sample of quotes in Table 7:

Table 7. Quotes presenting additional reasons of motivation of CS to SDGs

Main aspect	Quotes
Added value	<i>"Transformer role of Science in Society"</i> . <i>"A good context for work on Education for Sustainable Development"</i> . <i>"Impacts on participant's life such as health effects of air pollution"</i> . <i>"Relevance and impact of CS if aligned with SDGs"</i> <i>"Creates new types of data, added value, and opportunities for financing, especially from big conservation NGOs"</i> .
Peer pressure	<i>"The others do it, so you have to do to"</i> . <i>"Local communities and local experts should be involved in the implementation of SDG using a bottom-up approach"</i> .
Ideology and responsibility	<i>"I think that CS is intrinsically linked with SDGs, explicitly or not"</i> . <i>"Contribute to big issues affecting humanity and the planet"</i> . <i>"Explicitly doing CS to reach SGDs"</i> . <i>"The opportunity to make an impact on society and environment"</i> <i>"Overarching societal goals, linked with projects and 'co-benefits'"</i> .

While there is a general understanding that CS can contribute to reaching the SDGs and feed into the 2030 framework, the responses show balanced opinions on how this contribution can be increased, as presented in Figure 4.

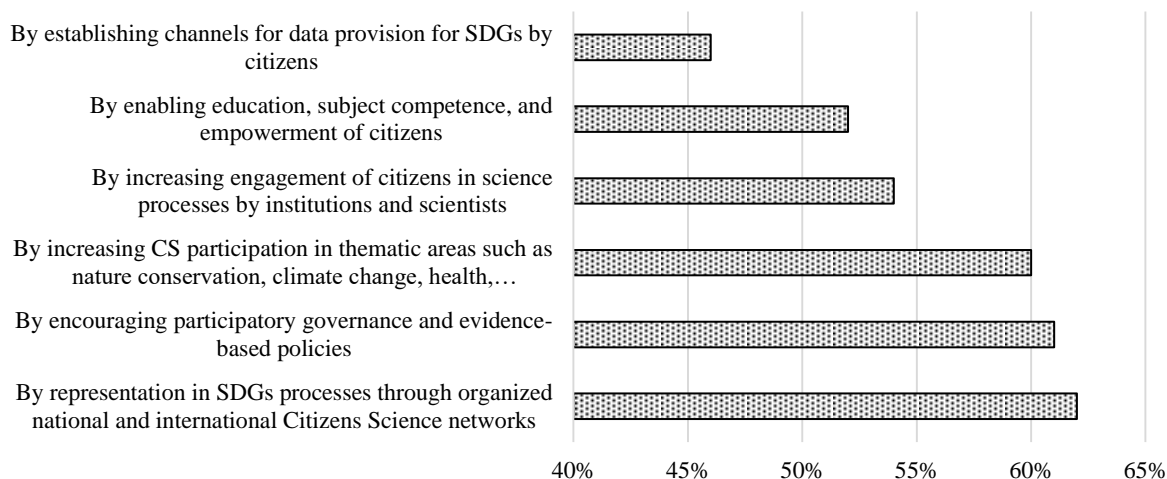


Fig. 4. Initiatives to increase the contribution of CS towards the SDGs

More opinions were expressed in the option “Others” and are explained in the quotes in Table 8:

Table 8. Quotes presenting additional opinions how CS contribution to the SDGs can be increased

Main aspect	Quotes
International aspect	<p>“By supporting the already existing CSGP in their work with the UN (hopefully beyond environmental issues)”.</p> <p>“By complementing and following up global efforts on national, regional and local scale, in a coordinated manner and in collaboration with Citizen Science associations (where they already exist)”.</p>
CS standard	<p>“Through developing standards for CS data, working closely with NSOs and UN custodian agencies, etc”.</p> <p>“By placing this work in the context of citizen generated data”.</p> <p>“Through making finance available for CS projects that adhere to SDG”</p>
Research and education	<p>“Through education of professional scientists”.</p> <p>“Researcher-driven partnerships and projects with citizen participants”</p> <p>“Through research on the potential of CS to implement the SDGs and in particular on the transformational learning aspects within CS projects to implement the SDGs”.</p>

4.6 Discussion

a) *Critical aspects for Citizen Science and the Agenda 2030 for Sustainable Development according to the 5 “collaboration channels”*

While similar critical elements in respect of the concept of citizen science in relation to sustainable development exist, this paper specifically focuses on the differences amongst

those. Therefore, Table 9 presents the two perspectives considered: 1) The Agenda 2030 political perspective and 2) the Citizen Science perspective, with the purpose to point out to possible problems and challenges.

Table 9. Critical aspects for each of the 5 channels of collaboration from the Citizens Science perspective and the Agenda 2030 for Sustainable Development perspective

Collaboration Channels	1. Critical aspects from Citizen Science perspective	2. Critical aspects from the Agenda 2030 perspective
a) Influence through representation of organized CS networks, in the multi-stakeholder partnerships and engagement mechanism created for the SDGs, on the national and international level.	Not all countries have organized CS communities or networks.	Not all countries have created multi-stakeholder partnerships for SDGs.
	CS is more widespread in developed regions (US, Europe, Australia).	Not all the countries have extended participation of non-state actors to the national platforms or committees for SDGs.
	Not all countries have strategies of CS in place at national or local levels.	Differences in the country's political will and commitment toward SDGs
	No infrastructure of involvement in national or local levels. (55% of respondents)	Difficulties in coordination and securing a fair representation of all stakeholders in multi-stakeholder platforms.
b) Influence through contribution to each of the SDGs individually, by actions that contribute to solving sustainability issues i.e. nature conservation, climate change, health, etc.	Citizen Science contribution is mainly for the environmental issues and environmental Indicators.	Difficulties to connect local sustainability challenges with SDGs.
	CS contribution is very low in some fields, i.e. agriculture.	Trade-offs and negative effects between some of the Goals.
	Participation of Citizen Scientists in projects for specific SDGs depends on the degree of involvement of the organizations or scientists.	Organizations need extra work and resources to identify the links to SDGs.
	Organizations do not explain the project connection with SDGs to the Citizen Scientists.	The ambiguity of organizations for SDGs can keep the projects contributing to the sustainability challenges, without feeding to the SDGs reporting framework. (Shulla et al, 2019).
	The participation doesn't extend to all level of citizens.	Lack of awareness for the Agenda 2030.
	Lack of the tools of technologies that allow CS to contribute, i.e., air quality, water quality.	
c) Influence through involvement in the policy cycle.	Exclusion of CS by institutions	Difficulties in aligning national and local agendas to the SDGs Targets and Indicators.
	Insufficient coordination	
	No official rules are in place by Public Institutions to include CS.	Lack of coordination at different levels and sectors.
	Lack of participatory approach in	No commitment to the SDGs from

	governance. Resistance from decision-makers and difficult to identify policy linkages.(Turbe et al. 2019)	local governments of some countries.
d) Influence through education	Confusion in CS of what is really learned by the participants. Not always CS projects contribute to the empowerment or education of the citizens or increase their subject competency. Lack of CS in the curricula. CS harvests only the knowledge of educated people. Organizations or scientists that include citizens neglect to give the required training when necessary. Environmental ethics of companies drive environmental training and performance (Singh et al, 2019)	SDG 4, on “Quality Education” influence all the Goals but there is no clear understanding of how (Shulla et.al 2020). Long term process to receive the results of education. Does not reach all levels of society. Lack of awareness about the SDGs and lack of their communication
e) Influence through the SDGs’ monitoring and reporting, as a source for data provision.	No recognition of data provided by CS. Problems with data accountability, ownership, validity. No infrastructure for data provision. Limitations in data portability, central to citizen science, for transferring the data to other sources (Quinn, 2018) No continuity after the project is closed. There is a major CS contribution on the virtual level and provision of data on line, which make it difficult to feed to the SDGs monitoring framework.	Slow process of data monitoring and reporting. For some of the SDGs indicators, classified in Tier III, no internationally established methodology or standards are yet available (UNDESA 2019). No infrastructure capacities for harvesting unofficial and non-traditional data.

This table is based on the survey results, takes into account the available literature, and the authors’ reflections on this combination of resources.

b) Framework of interactions for CS and SDGs on different levels

A framework for the potential interactions between CS and the SDGs is developed in order to explain a broader and more effective engagement. This model is based on different approaches (top-down and bottom-up) and involves specific actions, main actors, and potential collaborations. This framework is presented in Figure 6. It illustrates the paths of contributions between actors, identifying their connection with the collaboration channels (a) the representation of organized networks in the multi-stakeholder partnerships; (b) the

contribution to each of the SDGs; (c) the involvement in the policy cycles; (d) education and (e) data provision, on different levels.

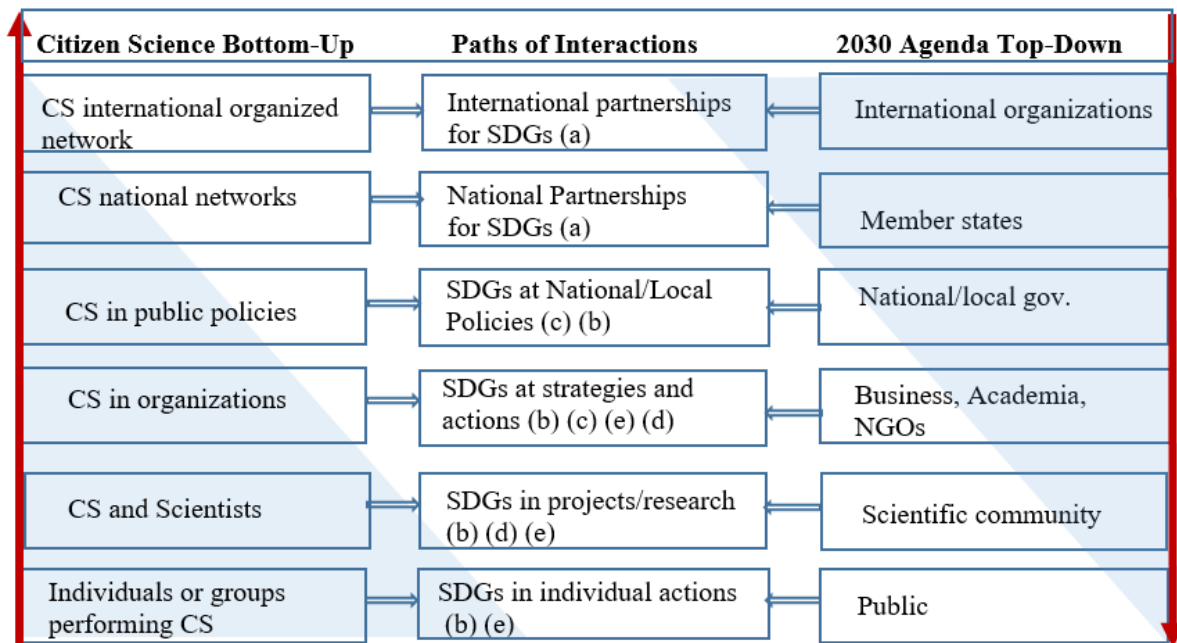


Fig. 6. Framework of interaction for Citizen Science and the Agenda 2030 for Sustainable Development

The framework of interaction considers the paths of contribution by starting bottom-up for CS, in the sense that input coming from the citizens can influence more the Goals than other forms of engagement. Bottom-up examples, such as civic and DIY (Do It Yourself) projects have more potential for contributing to diversity in the SDGs (European Commission, 2017). The citizen’s involvement in science can be either top-down, to generate data for scientists, or bottom-up, i.e. students or teachers raising new research questions (Mueller et al., 2012), but the level of engagement or position in the top-down and bottom-up spectrum can change during time. To support the growing movement of CS in Europe and beyond through communities and international players, both top-down and bottom-up approaches are necessary (Socientize, 2013).

On the other hand, the influence of the Agenda 2030 for CS starts from the top-down, given the national commitments role. Paragraph 47 of the Agenda 2030 states that governments have the primary responsibility for follow-up and review of the progress, at the national, regional and global level, in relation to the progress made in implementing the Goals and Targets until 2030 (UN 2015). Despite the encouragement, the bottom-up initiatives have not yet reached all levels of society. For example, the German Federal Government, in order to

implement the SDGs, is committed to the “top-down” approach, but also supports the individual federal states, and a wide range of actors to accelerate the “bottom-up” approach (Scholz et al., 2016). The enforcement of the links between CS and the Agenda 2030 (as shown in Figure 6) implies mutual benefits and bigger contribution to the 17 SDGs, as focus areas for the achievement of sustainable development and the well-being of the people (UNSSC, 2019).

c) Implications for each “collaboration channel”

The results of this paper contribute to generate the following discussions, organised by “collaboration channels”:

a) Channel (a): Influence through the representation of organized Citizen Science networks in the multi-stakeholder partnerships and engagement mechanisms created for the SDGs, at the national and international level. A certain degree of institutionalization is needed to participate in partnership processes for the Goals, both on the national and international level. Organized CS groups or networks can be more present in multi-stakeholder settings that national governments are organizing in order to fulfil their SDGs commitments, for instance in national councils, inter-ministerial groups, and multi-stakeholder committees for consultation processes (UNDP, 2017). Thus, an increase of CS organized groups, where is not yet widely practiced, can facilitate their representation and can diversify the engagement of non-state actors to the whole SDG processes. While the coordination of European Citizen Science networks across Germany, Austria, Switzerland, and Spain have resulted in active national online platforms (Strasser and Haklay, 2018), more governmental support from other countries is needed to include CS in national strategies. Furthermore, an agreement of citizen Science understanding and criteria must be established to ensure consistency and data consideration by policymakers (Heigl et al., 2019). On the other hand, the lack of a generally accepted definition of CS allows for methodical innovation and considerable heterogeneity (Eitzel et al., 2017).

b) Channel (b): Influence through contribution to each of the SDGs individually, by actions that contribute to addressing sustainability issues and themes, i.e. nature conservation, climate change, health, etc. Citizen Science has the potential to make a major contribution at the local level, as SDGs will be delivered locally. Progress could be reached by including contribution and data from citizens for Goal 11, “Sustainable Cities and Communities”

(Klopp 2017), for example. Exploring funding sources for this purpose would increase the resources for participation, as highlighted by the quote of a respondent: *“Encouraging CS projects to incorporate SDGs into their funding and reporting”*. Despite the voluntary character of CS, local governments can provide funding programs for citizens with specific focus to the SDGs. Often voluntary commitments compromise the success of practices (e.g. failures in the Corporate Social Responsibility on a case study presented by Patnaik et al. (2017)). Investing in CS can help local governments to facilitate the SDGs because participatory approaches and citizen involvement in policy making are required to reach the several targets. CS can also help localize the SDGs, such as Goals 3, 4, 11, 13, 15, which were also among the Goals mostly chosen by the participants of this study (see Figure 3). Community’s role for climate change adaptation is very important and can be dependent on gender, values, individual point of views and places (Brink and Wamsler, 2019). The contribution of CS projects in agriculture is low, but they can be useful for addressing food safety and nutrition, which contribute to Goal 3 on health and well-being (Ryan et al., 2018).

c) Channel (c): Influence through involvement in the policy cycle. Stronger involvement of CS in the policy cycle could result in a better implementation of the Agenda 2030, especially for achieving the Targets and Indicators that depend on participatory practices. Governments can benefit from Citizen Science as a tool for public participation or as a source to close information gaps (Hadj-Hammou et al., 2017). Successful participation can also depend on how the participatory practices are designed. For instance, when designed as research, apart from the learning, they can feed to data gathering and a better outreach of science-policy in society (Damon, et al., 2016). Ineffective participation can increase decision-making costs, but participation of the public and enterprises in the government processes can increase the efficiency, e.g., air emissions control, and contribute to reaching the SDGs (Li et al., 2018). The influence of Citizen Science and community engagement in public health policies is increasing, mainly through contributing to health literacy, cohesion and rationality (Den Broeder et al., 2018).

d) Channel (d): Influence through education. An increase of CS-oriented projects from organizations or individuals can also contribute to the educational element of the Agenda 2030, by increasing the competence of the participants. The selected quotes below were added as additional information from the respondents.

Quote: “SDGs are more a vision of politics. When somebody takes part in the project, they do not realize the dimension of the project. If SDGs are clearly

mentioned people would know what they do. Scientists must explain to the participants of the project the link to SDGs. It is the task of organizations to make the alignment”.

Quote: “CS projects often arise from a scientific problem which doesn't naturally relate to the SDGs. However, finding the connections and highlighting them would increase the success of both CS projects and SDGs”.

Increasing the presence of CS in the private sector, civil society and academia is needed, but it has to be based on equal terms of partnerships. Many companies and organizations are under a lot of pressure to implement sustainability (Caiado et al., 2019). It can be achieved through alignment with the Agenda 2030, integration of the SDGs into existing projects, and by involving more citizen scientists and communicating the SDGs to them. It can require innovation, which is important for technology, economy and social development, (Oliva et al, 2018) and organizational changes towards more sustainable policies and practices (Jabbour et al, 2019). Furthermore, transformative leadership plays a role in green innovation and environmental performance of organizations (Singh, 2019).

e) Channel (e): Influence through the SDGs’ monitoring and reporting, as a source for data provision. Citizen Science data are important for the Agenda 2030, if integrated in the SDGs’ reporting and monitoring frameworks. The five dimensions of CS data- spatial, temporal, thematic, process, and management, based on their various features appear to be valuable for the SDGs (Fritz et al., 2019). They are particularly useful, if distinguished from traditional science data, for instance in recording species in diverse areas where other methods are not possible (Klemann Junior et al., 2017). Managing big data, from a variety of sources, can help companies overcome technological challenges (El-Kassar and Singh 2017), and facilitate the development of their sustainable capabilities (Singh and El-Kassar, 2018). Citizen-generated data can improve monitoring practices by offering alternative measurement methods (Lämmerhirt 2018). The e-infrastructure of data provision is an important aspect of CS, because CS often happens on the virtual level. “Online citizen science” can reinforce scientific research infrastructure with very few resources (Nov, 2014). In order to foster specific policies, CS programs should keep their internal sustainability through internal evaluations, publishing studies and leadership diversity (McGreavy et al., 2016). Effective tools for integrating CS data to the SDGs framework should be established, (for instance e-infrastructure of SDGs data reporting and monitoring) and open access to CS research should be encouraged.

4.7 Conclusions

Citizen Science and the SDGs share the same values for global sustainability challenges and empowering people. The partnership character of the Agenda 2030 allows for collaboration at different levels of society, and envisions the voluntary contributions that are often overlooked. Citizen Science has multiple outcomes, and every single commitment is essential for the SDGs. Citizen Science commitments to sustainability can comprise not only sensitive environmental issues but address all three dimensions of sustainability.

The results of this study indicate a big potential of interactions through the five “collaboration channels”. The results point out to the involvement of Citizen Science activities mainly with SDG 4 “Quality Education”, SDG 11 “Sustainable Cities and Communities”, SDG 13 “Climate Action” and SDG15 “Life on Land”; to the need for institutionalization of CS representation in the national and international SDGS processes; to the importance of CS data infrastructure for the SDGs monitoring framework; to the mutual benefits of CS and SDGs from strengthening education and competencies; to the increase of presence of Citizen Science in companies through fair partnerships; and to the importance of Citizen Science in the policy cycles which helps the governments in fulfilling their commitments to the SDGs. Enforcement of CS links and paths of interaction with the SDGs can increase CS recognition and acknowledgment as a valuable source of contribution for sustainable societies. It can also help citizens and organizations to develop a better awareness of the value of the Agenda 2030 for the Sustainable Development.

4.7.1 Implication for Theory and Practise

The study contributes to the literature on Citizen Science. It explores the role of the CS discipline in achieving the global objectives toward a sustainable society. Regarding practical contributions, it supports the CS community, practitioners and policy makers by providing better insights and hints for synergizing their work and raising awareness about the potential of CS contributions for the Agenda 2030. Furthermore, the study contributes to the research on the Agenda 2030 and the SDGs, and the necessary collaborations needed between disciplines and actors. It points out critical aspects of these contributions and gives practical recommendations for increasing CS involvement with the SDGs.

4.7.2 Limitations of the study and suggestions for future work

Reaching a greater number of participants in the online survey would have certainly strengthened the results of this study, as it would have assured a wider and more diverse

representation of participants, since a major part of them belong to national or international CS networks or organizations. The aim was not to narrow the results by focusing only on network administrators, but instead to welcome responses and insights from a wide range of CS practitioners with various disciplinary backgrounds. The majority of the participants are from Europe, so the relatively small sample size of participants from the other continents does not allow for representation of a larger population. The sample represents the overall group surveyed, and despite being a small sample, the data reliability is assured since the sample is composed of researchers who are really engaged with Citizen Science and familiar with its concept and practice. The optimal sample size was not calculated in advance, as it was expected to reach the largest possible number of participants, considering their availability and degree of involvement. The Cost Action on Citizen Science community network is composed of about 275 practitioners. Thus, the response rate is approximately 25%, which includes also the participants from other domains as described in the methodology. More participation from citizen scientists and policymakers would have provided a better and more representative understanding of their points of view. For this purpose, dissemination to a broader audience outside the above groups would have obtained more diverse results. Another limitation of this study is the lack of information on examples or case studies of current actions of CS and the SDGs related activities. Future research should focus on the different channels of CS contributions for the implementation of the Agenda 2030 for Sustainable Development and in identifying new forms of cooperation. More specifically, future research can consider the following:

- Governance aspects of Citizen Science organized networks and institutionalization of CS actions for SDGs
- Financial aspects of Citizen Science and SDGs
- Citizen Science and SDGs in developing countries
- Citizen Science's role for thematic issues of the SDGs related to, for instance, climate change, agriculture, sustainable cities, education etc.
- Role of Citizen Science for localizing the SDGs, by contributing to the attainment of the SDGs Targets related to participatory planning and public involvement
- Citizen Science's contribution to sustainable development in different sectors, such as the private sector, civil society, the public sector and academia
- Citizen science, Global Citizenship and Education for Sustainable Development
- Exploring tools to integrate CS data in the SDGs framework

5. Discussion and Conclusions

The UN High Level Political Forum (HLPF) in September 2019 on the “SDG Summit”, assessed the progress and challenges ahead at the end of a four-year review cycle of all 17 SDGs, concluded that so far there has been a lack of political leadership and guidance at the international level and that the current stage is far from reaching the SDGs. The timeframe for the SDGs implementation has entered the “Decade of Action” until 2030. The HLPF highlighted three specific needs for that: 1) global action to secure greater leadership, more resources and smarter solutions for the SDGs; 2) local action embedding the needed transitions in the policies, budgets, institutions and regulatory frameworks of governments, cities and local authorities; and 3) people action, including by youth, civil society, the media, the private sector, unions, academia and other stakeholders, to generate an unstoppable movement pushing for the required transformations (<https://www.un.org/sg/en/content/dsg/statement/2019-12-19/deputy-secretary-generals-opening-remarks-informal-briefing-member-states-the-decade-of-action-prepared-for-delivery>).

The emphasised needs, by concentrating on “*global*”, “*local*”, and “*people*”, would give importance to the involvement and increasing responsibilities of other actors, and contributions from all sources. Because until there are no clear roles assigned to the implementation of the Goals, national governments remain the main responsible actors for the SDGs implementation. The 2030 Agenda defines targets and indicators without assigning strategies, so there is no clear role who implements what (Hege, 2019). Furthermore, unbalanced development in different countries, political will or whether countries prioritise sustainability, and financing are major obstacles for the 2030 Agenda.

This study has analysed the role of diverse non-state actors and disciplines in the process of achieving the 17 SDGs, giving an overview of current involvement and understandings of the difficulties, impeding challenges and opportunities. It shows to what extent, during the first years of the 2030 Agenda, the SDGs were implemented by diverse multi-stakeholder networks, groups and organizations, based on current evidence and on clear contextual settings. This study as well identifies financial issues and governance bottlenecks, uneven progress between Goals and regions, weak coordination mechanisms among stakeholders, silo approaches with the goals, etc. to be the major challenges for achieving the SDGs. In order to embrace the SDGs in their strategies, programs, work and actions, networks,

organizations, groups and individuals would need additional financial resources and efforts. Donors are in favour of some of the SDGs, and unlocking private capital to achieve these and others so far has not always been successful.

The 2030 Agenda acknowledges the role of governance for the SDGs in Goals 16 and 17. New governance models at multi-levels, are needed to coordinate the SDGs and embrace the wide range of actors in the process. Global governance and regulating mechanisms at international level are necessary as national strategies will not be enough. Since networks and partnerships are dependent on their regional contexts and other circumstances, stronger cooperation with international organisations active in the SDGs implementation process would secure them a better position in the international arena. The study reinforces the idea that non-state actors can contribute outside their country contexts, at both local and international scale.

The role of local governments is becoming more and more important. *“The SDGs provide an unprecedented opportunity to align global, national and subnational priorities, however, increased capacity and awareness of the transformative nature of the 2030 Agenda are needed that subnational governments everywhere to use the SDG framework as a tool for the long-term transition towards sustainability”* (<https://doi.org/10.1787/23069341>). Furthermore, many big cities are issuing Voluntary Local Reviews (VLRs), beyond national Voluntary National Reviews, which show their commitment for the SDGs. Localizing SDGs and operationalization to concrete measures is important as 60% of the targets will be delivered at the local level. *“Regional assets are critical to achieve the 2030 Agenda because of the cross-border nature of today’s greatest challenges, including climate, trade, health and conflict”* (UN 2019). But to localise global agendas, so they do not remain abstract, does not mean to implement strategies determined at a higher level, but requires matching the national priorities as derived from the global agendas, with the local priorities as determined by local stakeholders (<https://www.adb.org/sites/default/files/publication/316991/governance-brief-30.pdf>).

There are mutual benefits for non-state actors and public institutions in collaborating for achieving the SDGs. It is an opportunity for access in participation in decision processes and to financial channels. On the other hand, the public institutions can increase transparency and willingness to participatory practices, increase democratic elements of governance, and perform better for the SDGs, because in order to reach several Targets, participatory approaches and citizen involvement in policy making is essential. Key governance

challenges, such as collective action and inclusive decision making, are crucial for the SDGs implementation.

This study identifies insufficient involvement and a lack of clarity about the Targets and Indicators. There are difficulties in aligning a SDGs monitoring framework with the internal processes, thus not feeding to the global monitoring framework, even when there are considerable contributions to the SDGs, which leads to an unmeasured performance. The provision of a set of targets and indicators in given contexts, with strongest positive interdependence would orient future policies and programs.

Another important element is the synchronization of different agendas, for SDGs to be a common language. The study identifies that both ESD and CS, can serve as connecting elements for Partnerships for the Goals. ESD, as a dynamic concept, includes all actions and challenges towards sustainable development, and is at the core of global goals for a sustainable future, while CS and SDGs share the same values of increasing awareness of global sustainability challenges and empowering people. Although the nature of multi-stakeholder networks allows for diverse approaches of ESD towards the 2030 Agenda, the study indicates the importance of partnership and informal learning for reflection of global sustainability issues such as climate change, energy, sustainable cities, natural habitat, consumption and production etc. Coordinating CS related activities with the SDGs can help citizens and organizations develop a better awareness of the value of the 2030 Agenda.

Evaluating the impact of partnerships is a challenge. Emphasis has to be on optimising the conditions for the partnerships so that they can be more effective for the SDGs implementation. A certain degree of institutionalization is needed to participate in partnership processes for the Goals, both at the national and international level. SDGs coordination would require vertical and horizontal outreach. The study shows that the networks of RCEs have stronger cooperation at the horizontal level, but an improved vertical outreach would require a stronger involvement in national processes for the SDGs. These networks have a favourable position in between their regions and international organizations, which in the context of SDGs should be better exploited.

Some limitations of this study are related to novelty and complexity of the topic, and the number of respondents in the surveys conducted. The study contributes to the literature for the 2030 Agenda by providing evidence for the SDGs, through tracking and measuring the progress, data processing and analyses, in diverse disciplines and in clear contextual settings. It is relevant for the SDGs governance and networks' impact evaluation studies. It facilitates

direct practical contributions for the community of multi-stakeholder networks like RCEs and the practitioners and communities of CS.

5.1 Outlook

Research for sustainability should be linked to the reality, looking beyond the 2030 Agenda and continuously adjust to suitability challenges. The “SDGs Summit” in 2019 stressed the need for new scientific research and its subsequent adoption to specific local and regional contexts in order to exploit Goal synergies and look beyond 2030 (UN 2019). The sustainability debate has recently gained momentum and public attention. This offers an opportunity to weave sustainability concepts into the mainstream at many different societal levels and may even push governments towards the implementation of meaningful policies which address and implement the SDGs. While policy changes in the development spectrum of countries are not the same, research can focus on the inherent political and policies dimensions.

Future themes for research can be related to:

- Resilience character of the 2030 Agenda in crisis and unexpected world challenges
- Development of new Governance approaches for the SDGs during the decade of action until 2030
- The gap between policy and research in the context of the 2030 Agenda
- Impact evaluation of coalitions and collaborations for the SDGs (2015-2030)
- National/local policies potential conflicts with the 2030 Agenda framework
- Nature based solutions as means to achieve the SDGs
- Citizens empowerment for achieving the SDGs
- Open Science effects for the 2030 Agenda

6. References

1. Arico S. 2014. The contribution of the sciences, technology and innovation to sustainable development: the application of sustainability science from the perspective of UNESCO's experience. *Sustain Sci.* 9. p.453-462.
2. Bexell, M. and Jönsson, K. 2017. Responsibility and the United Nations' Sustainable Development Goals. *Forum for Development Studies*, 44:1, 13-29. doi: 10.1080/08039410.2016.1252424.
3. Biermann, F., Kanie, N., & Kim, R. E. (2017). Global governance by goal-setting: the novel approach of the UN Sustainable Development Goals. *Current Opinion in Environmental Sustainability*, 26, 26-31. 10.1016/j.cosust.2017.01.010.
4. Bio Innovation Service, EU publications. 2018. Citizen science for environmental policy: development of an EU-wide inventory and analysis of selected practices. doi:10.2779/961304.
5. Bowen, K., Cradock-Henry, N., Koch, F., Patterson, J. Häyhä, T., Vogt, J. and Barbi, F., (2017). Implementing the “Sustainable Development Goals”: towards addressing three key governance challenges—collective action, trade-offs, and accountability. *Current Opinion in Environmental Sustainability*. <http://dx.doi.org/10.1016/j.cosust.2017.05.002>.
6. Brink, E. and Wamsler, C. 2019. Citizen Engagement in climate adaptation surveyed: The role of values, worldviews, gender and place. *J. Clean. Prod.* 209, (1342-1353). doi.org/10.1016/j.jclepro.2018.10.164.
7. Caiado, R., Leal Filho, W., Quelhas, O. & Nascimento, D. & Ávila, L., (2018). A Literature-Based Review on Potentials and Constraints in the Implementation of the Sustainable Development Goals. *JCLP*. DOI: 10.1016/j.jclepro.2018.07.102.
8. Caiado, R.G.G. Quelhas, O.L.G., Nascimento, D.L.M., Anholon, R. and Leal Filho. W. 2019. Towards sustainability by aligning operational programmes and sustainable performance measures. *Prod. Plan. Control.* 30:5-6, 413-425. doi: 10.1080/09537287.2018.1501817.
9. Casini M, Bastianoni S, Gagliardi F, Gigliotti M, Riccaboni A, Betti G. 2019. Sustainable Development Goals indicators: A methodological proposal for a multidimensional fuzzy index in the Mediterranean area. *Sustainability.* 11(4), 1198.
10. Ceccaroni, L., Bowser, A., and Brenton, P. 2017. Civic Education and Citizen Science: Definitions, Categories, Knowledge Representation. In Ceccaroni, L., and Piera, J.(Eds.), *Analyzing the Role of Citizen Science in Modern Research* (pp. 1-23). Hershey, PA: IGI Global. doi:10.4018/978-1-5225-0962-2.ch00.
11. Chari, R., Matthews, L.J., Blumenthal, S.M., Edelman, F.A., Jones, Th. 2017. The Promise of Community Citizen Science. RAND Corporation. <https://www.rand.org/pubs/perspectives/PE256.html>.
12. Chung BG, Park I. 2016. A review of the differences between ESD and GCED in SDGs: focusing on the concepts of global citizenship education. *Journal of International Cooperation in Education.* 18 (2). p. 17-35. CICE Hiroshima University, Japan.
13. Citizen Science Global Partnership. <http://citizenscienceglobal.org> (accessed on April 2019).
14. Damon, M.H., Gilbertz, S.J., Anderson, M.,B., and Ward, L.C. 2016. Beyond “buy-in”: designing citizen participation in water planning as research. *J. Clean. Prod.* 133, (725-734). doi.org/10.1016/j.jclepro.2016.05.170.
15. Den Broeder, L., Devilee, J., Van Oers, H., Schuit, A.J., and Wagemakers, A. 2018. *Health Promot Int.* 33(3):505-514. doi: 10.1093/heapro/daw086. PMID: 28011657.
16. DITOS Consortium. (2019). *Citizens Science in UK Environmental Policy*. UCL discovery. Policy brief 7.
17. DITOS Consortium. 2019b. *Unleashing the potential of citizen science as an educational tool toward the sustainable Development Goals (SDGs)*. UCL Discovery. Policy brief 9.
18. Dlouhá, J., Barton, A., Huisingh, D., & Adomssent, M. (2013). Learning for sustainable development in regional networks. *JCLP*, 49, 1-4.
19. Dlouha, J., Henderson, L., Kapitulčinová, D., & Mader, C. (2018). Sustainability-oriented higher education networks: Characteristics and achievements in the context of the UN DESD. *JCLP*, 172, 4263-4276. doi.org/10.1016/j.jclepro.2017.07.239.
20. Douthwaite, L. and Sprinks, J. 2019. Citizen Science and the professional-amateur divide: lessons from differing online practices. *JCOM* 18 (01), A06. <https://doi.org/10.22323/2.18010206>.
21. Eitzel, M.V., Cappadonna, J.L., Santos-Lang, C., Duerr, R.E., Virapongse, A., West, S.E., et al. 2017. *Citizen Science Terminology Matters: Exploring Key Terms*. *Citizen Science: Theory and Practice*, 2(1), p.1. DOI: <http://doi.org/10.5334/cstp.96>.

22. Elliott, KC and Rosenberg, J. 2019. Philosophical Foundations for Citizen Science. *Citizen Science: Theory and Practice*. 4(1): 9, pp. 1–9, doi: <https://doi.org/10.5334/cstp.155>.
23. Elliott, T., Alisic, E., Stoepler, T. 2019. Improving Scientific Input to Global Policymaking with a focus on the UN Sustainable Development Goals. The InterAcademy Partnership. https://www.interacademies.org/50429/SDGs_Report. (accessed on August 2019).
24. Emerson, K., Nabatchi, T., Balogh, S. (2012). An Integrative Framework for Collaborative Governance. *J. Public Adm. Res. Theory*. 22(1), 1-29. doi:10.1093/jopart/mur011.
25. European Commission. 2017. Report from the commission to the European Parliament, the Council, the European economic and Social Committee and the Committee of the regions. European Commission (COM (2017) 312). http://ec.europa.eu/environment/legal/reporting/pdf/action_plan_env_issues.pdf (accessed on 27 April 2019).
26. Frei, B. (2018). Research Methods in Encyclopedia of educational research, measurement, and evaluation, 1-4. SAGE. doi: 10.4135/9781506326139
27. Fritz, S., See, L., Carlson, T. et al. 2019. Citizen science and the United Nations Sustainable Development Goals. *Nat Sustain* 2, 922–930. doi:10.1038/s41893-019-0390.
28. Giangrande N, White RM, East M, Jackson R, Clarke T, Saloff Coste M, Penha-Lopes G. 2019. A competency framework to assess and activate education for sustainable development: addressing the UN Sustainable Development Goals 4.7 Challenge. *Sustainability*. 11(10), 2832.
29. GIZ, (2017). Multi-stakeholder partnerships in the context of Agenda 2030. <https://www.partnerschaften2030.de/wp-content/uploads/2018/10/Multi-stakeholder-partnerships-in-the-context-of-Agenda-2030.pdf> (accessed on April 2019)
30. Global RCE Network of Education for Sustainable Development, <https://www.rcenetwork.org/portal/node/3352> (accessed on May 2019).
31. Gouraguine, A., Moranta, J., Ruiz-Frau, A., Hinz, H., Reñones, O., Ferse. S.C.A., et al. 2019. Citizen Science in data and resource-limited areas: A tool to detect long-term ecosystem changes. *PLOS ONE*. 14(1): e0210007. doi.org/10.1371/journal.pone.0210007.
32. Guerrini, C.J., Majumder, M.A., Lewellyn, M.J., McGuire A.L. 2018. Citizen Science, Public Policy. *Science*. Vol. 361, Issue 6398, pp. 134-136. DOI: 10.1126/science.aar8379.
33. Hadj-Hammou, J., Loisselle, S., Ophof, D., Thornhill, I. 2017. Getting the full picture: Assessing the complementarity of citizen science and agency monitoring data. *PLOS ONE*. 12(12): e0188507. doi.org/10.1371/journal.pone.0188507.
34. Haklay M., Mazumdar S., Wardlaw J. 2018. Citizen Science for Observing and Understanding the Earth. In: Mathieu P., P., Aubrecht, C. (eds) *Earth Observation Open Science and Innovation*. SSI Scientific Report Series, vol 15. Springer, Cham. doi.org/10.1007/978-3-319-65633-5_4.
35. Hecker, S., Haklay, M., Bowser, A., Makuch, Z., Vogel, J. & Bonn, A. et al. 2018. *Citizen Science: Innovation in Open Science, Society and Policy*. London: UCL Press. 2018. doi .org /10 .14324 /111.9781787352339.
36. Hege, E. (2019). Deciding What to Think of the First Four Years of SDG Implementation. IDRI. <https://www.iddri.org/en/publications-and-events/other-publication/deciding-what-think-first-four-years-sdg-implementation>.
37. Heigl, F., Kieslinger, B., Paul, K., T., Uhlik, J., and Dörler, D. 2019. Opinion: Toward an international definition of citizen science. *PNAS*. 2019. 116 (17) 8089-8092. doi.org/10.1073/pnas.1903393116.
38. Husson, F. and Josse, J. (2014). Multiple Correspondence Analysis. The Visualization and Verbalization of Data, Chapter: Multiple Correspondence Analysis. CRC/PRESS.
39. ICSU (2017). A Guide to SDG interactions: from science to implementation. In: International Council for Science, Paris. <https://council.science/cms/2017/05/SDGs-Guide-to-Interactions.pdf> (accessed on April 2019).
40. ICSU. International Social Science Council. 2017. A guide to SDG interactions: from science to implementation. In: International Council for Science. Paris. <https://council.science/cms/2017/05/SDGs-Guide-to-Interactions.pdf> (accessed 2019, April 29).
41. Irwin, A. 2018. Citizen Science comes of age. *Nature*. 562, 480-482. doi: 10.1038/d41586-018-07106-5.
42. Janouskova, S., Hak, T. and Moldan, B. (2018). Global SDGs Assessments: Helping or Confusing Indicators? *Sustainability*, 10(5):1540. DOI: 10.3390/su10051540.
43. Jordan C.R., Ballard H.L., Phillips, T.B. 2012. Key issues and new approaches for evaluating citizen-science learning outcomes. *Ecological Society of America*. <https://doi.org/10.1890/110280>.
44. Josephsen, L. 2017. Approaches to the implementation of the Sustainable Development Goals – some considerations on the theoretical underpinnings of the 2030 Agenda. Kiel Institute for the World Economy. Economics Discussion Papers, No 2017-60.

45. Kemp, R., Parto, S. and Gibson, R.B. 2005. Governance for sustainable development: moving from theory to practice. *Int. J. Sustainable Development*. 8, Nos. 1/2, pp.12–30.
46. Klemann Junior, L., Villegas Vallejos, M.A., Scherer-Neto, P., Vitule, J. R.S. 2017. Traditional scientific data vs. uncoordinated citizen science effort: A review of the current status and comparison of data on avifauna in Southern Brazil. *PLOS ONE*. 12(12):e0188819. doi.org/10.1371/journal.pone.0188819.
47. Klopp M. J., Petretta, D.L. 2017. The urban sustainable development goal: Indicators, complexity and the politics of measuring cities. *Cities*. Vol, 63, p92-97. <https://doi.org/10.1016/j.cities.2016.12.019>.
48. Knack, A., Smith, E., Parks, S. and Manville, C. 2017. Open science: The citizen's role in and contribution to research. RAND Corporation and Corsham Institute. https://www.rand.org/pubs/conf_proceedings/CF375.html. (accessed on May 2019).
49. Kullenberg C, Kasperowski D. 2016. What is citizen science?—A scientometric meta-analysis. *PLoS One*. 11 (1).p. e0147152.
50. Kullenberg, C. and Kasperowski, D. 2016. What Is Citizen Science?—A Scientometric Meta-Analysis. *PLOS ONE*. 11 (1):e0147152.doi:10.1371/journal.pone.0147152.
51. Lambrechts W, Hindson J. 2016. Research and Innovation in education for sustainable development. Exploring collaborative networks, critical characteristics and evaluation practices. ENSI, ZVR-Zahl 408619713. Vienna, Austria.
52. Lämmerhirt, D., Jonathan G., Venturini, T., Meunier, A. 2018. Advancing Sustainability Together? Citizen-Generated Data and the Sustainable Development Goals. <http://dx.doi.org/10.2139/ssrn.3320467>.
53. Lautsch, E, and Plichta. M. (2003) Configural Frequency Analysis (CFA), Multiple Correspondence Analysis (MCA) and Latent Class Analysis (LCA): An empirical comparison. *Science*, Vol. 45, p. 298-323.
54. Lavrakas, P. (2008). Purposive Sample in *Encyclopedia of Survey Research Methods*. SAGE. doi: 10.4135/9781412963947.
55. Leal Filho W, Azeiteiro U, Alves F, Pace P, Mifsud M, Brandli L, Caeiro SS, Disterheft A. 2018. Reinvigorating the sustainable development research agenda: the role of the sustainable development goals (SDG), *INT J SUST DEV WORLD*. 25(2).p.131-142.
56. Leal Filho W, Manolas E, Pace P. 2015. The future we want: key issues on sustainable development in higher education after Rio and the UN decade of education for sustainable development. *IJSHE*. 16 (1). p.112-129.
57. Leal Filho W, Tripathi SK, Andrade Guerra, JBSOD, Giné-Garriga R, Orlovic Lovren V, Willats J. 2019. Using the sustainable development goals towards a better understanding of sustainability challenges. *INT J SUST DEV WORLD*. 26(2).p. 179-190.
58. Leal Filho W. 2009. Towards the promotion of education for sustainability. *Rev. Educ.* 33. P. 263–277. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.598.9759&rep=rep1&type=pdf> (accessed 2019, March 5).
59. Leal Filho, W., Azeiteiro, U., Alves, F., Pace, O., Mifsud, M., Brandli, L., et al. 2018. Reinvigorating the sustainable development research agenda: the role of the sustainable development goals (SDG), *Int. J. Sustain. Dev. World Ecol.* 25:2, 131-142. doi: 10.1080/13504509.2017.1342103.
60. Leal Filho, W., Tripathi, S. K., Andrade Guerra, J. B. S. O. D., Giné-Garriga, R., Orlovic Lovren, V., & Willats, J. (2019). Using the sustainable development goals towards a better understanding of sustainability challenges. *Int. J. Sustain. Dev. World Ecol.*, 26(2), 179-190. doi:10.1080/13504509.2018.1505674.
61. Leal Filho, W., Tripathi, S.K., Andrade Guerra, J.B.S.O.D., Gin_e-Garriga, R., Orlovic Lovren, V., Willats, J., 2019. Using the sustainable development goals towards a better understanding of sustainability challenges. *Int. J. Sustain. Dev. World Ecol.* 26 (2), 179e190. <https://doi.org/10.1080/13504509.2018.1505674>.
62. Leal Filho, W., Vargas, V. R., Salvia, A. L., Brandli, L. L., Pallant, E., Klavins, M., ... & Ayanore, M. A. (2019). The role of higher education institutions in sustainability initiatives at the local level. *Journal of Cleaner Production*, 233, 1004-1015.
63. Li, L., Xia, X.H., Chen, B., and Sun, L. 2018. Public participation in achieving sustainable development goals in China: Evidence from the practice of air pollution control. *J. Clean. Prod.* 201, (499-506). doi: 10.1016/j.jclepro.2018.08.046.
64. McCreavy, B., Calhoun, A. J. K., Jansujwicz, J., and Levesque, V. 2016. Citizen Science and natural resource governance: program design for vernal pool policy innovation. *Ecol Soc.* 21(2):48. doi.org/10.5751/ES-08437-210248.
65. Meuleman, L., Niestroy, I. (2015). Common but Differentiated Governance: A Metagovernance Approach to Make the SDGs Work. *Sustainability* 7, no. 9: 12295-12321. DOI: 10.3390/su70912295.

66. Mochizuki Y, Bryan A. 2015. Climate change education in the context of education for sustainable development: rationale and principles. *JESD*. 9 (1). p. 4-26.
67. Mochizuki, Y., & Fadeeva, Z. (2008). Regional centres of expertise on education for sustainable development (RCEs): An overview. *IJSHE*, 9(4), 369-381.
68. Morse, J. (2009). *Mixed Method Design*. New York: Routledge. <https://doi.org/10.4324/9781315424538>.
69. Morse, J. (2009). *Mixed Method Design*. New York: Routledge. <https://doi.org/10.4324/9781315424538>.
70. Mueller, M.P., Tippins, D., Bryan, L. 2012. The future of citizen science. *Democracy and Education*. 20 (1), 1e17. <https://democracyeducationjournal.org/home/vol20/iss1/2> (accessed on July 2019).
71. Mulholland, E. (2018). The implementation of the 2030 Agenda and the SDGs in Europe: Overview and Updates, *ESDN Quarterly Report 49*, July 2018, ESDN Office, Vienna. https://www.sd-network.eu/quarterly%20reports/report%20files/pdf/2018-July.The_Implementation_of_the_2030_Agenda_and_the_SDGs_in_Europe.pdf (accessed 4 April 2019).
72. NACSEM, National Academies of Sciences, Engineering, and Medicine. 2018. *Learning Through Citizen Science: Enhancing Opportunities by Design*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25183>.
73. Network of Regional Governments for Sustainable Development (2017). *SDGs at the Subnational Level: Regional Governments in the Voluntary National Reviews*. https://www.regions4.org/wp-content/uploads/2019/06/R4_SDGsatSubnationalLevel2017-1.pdf (accessed 13 July 2019).
74. Nilsson M. 2017. Important interactions among the Sustainable Development Goals under review at the high-level political forum 2017. *SEI Working Paper 2017-06*. Stockholm Environment Institute. Stockholm.
75. Nilsson, M. (2017). Important interactions among the Sustainable Development Goals under review at the High-Level Political Forum 2017. *SEI Working Paper 2017-06*. Stockholm Environment Institute, Stockholm.
76. Nilsson, M., Chisholm, E., Griggs, D. et al. (2018). Mapping interactions between the sustainable development goals: lessons learned and ways forward. *Sustain Sci*, 13(6), 1489-1503. doi:10.1007/s11625-018-0604-z.
77. Noguchi F. 2018. Critical reflections on the UNDESD: From the perspectives of informal education in a community development context. *JESD*. 11(2).p. 141-151.
78. Nov, O. Arazy, O. Anderson, D. 2014. Scientists@Home: What Drives the Quantity and Quality of Online Citizen Science Participation? *Plos one*. <https://doi.org/10.1371/journal.pone.0090375>.
79. Pattberg, P. and Widerberg, O. 2016. Transnational multi-stakeholder partnerships for sustainable development: Conditions for success, *Ambio*, 45:42–51. DOI 10.1007/s13280-015-0684-2.
80. Pattberg, P., and Widerberg, O. (2014). Transnational multi-stakeholder partnerships for sustainable development: Building blocks for success. Available at SSRN 2480302.
81. Peer, V., & Stoeglehner, G. (2013). Universities as change agents for sustainability-framing the role of knowledge transfer and generation in regional development processes. *JCLP*, 44, 85-95. doi.org/10.1016/j.jclepro.2012.12.003.
82. Pettibone L, Vohland K, Bonn A, Richter A, Bauhaus W, Behrisch B, Borchering R, Brandt M, Bry F, Doerdler F, et al. 2016. Citizen science for all, a guide for citizen science practitioners. GEWISS. Berlin. https://www.buergerschaffenwissen.de/sites/default/files/grid/2017/11/21/handreichunga5_engl_web.pdf. (accessed 2019, November 1).
83. Pettibone, L., Vohland, K., Bonn, A., et al., 2016. Citizen science for all, a guide for citizen science practitioners. *Bürger Schaffen Wissen (GEWISS) publication*. (iDiv) Halle-Jena-Leipzig, UFZ, Leipzig, BBIB, MfN, Leibniz Institute for Evolution and Biodiversity Science. www.buergerschaffenwissen.de (accessed on April 2019).
84. Pocock, J. O., Roy, H. E., August, T., Kuria, A., Fred Barasa, F., John Bett. J., Githiru, M., Kairo, J., Kimani, J., Kinuthia, W. et.al. 2018. Developing the global potential of citizen science: Assessing opportunities that benefit people, society and the environment in East Africa. *Journal of Applied Ecology* published by John Wiley & Sons Ltd on behalf of British Ecological Society. DOI: 10.1111/1365-2664.13279.
85. R Core Team (2013). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org/>.
86. R Core Team. 2013. *R: a language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org/>.

87. Raddick, M. J. Bracey, G. Carney, K. Gyuk, G. Borne, K. Wallin, J. Jacoby, S. 2009. Citizen Science: Status and Research Directions for the Coming Decade. *Astro2010: The Astronomy and Astrophysics Decadal Survey, Position Papers*, no. 46. <https://ui.adsabs.harvard.edu/abs/2009astro2010P..46R/abstract> (accessed Nov 2019).
88. Rasmussen, L.M. 2019. Confronting Research Misconduct in Citizen Science. *Citizen Science: Theory and Practice*. 4(1), p.10. doi.org/10.5334/cstp.207.
89. Reed, C.C., Winters, J.M., Hart, S.C., Hutchinson, R., Chandler, M., Venix, G., et al. 2018. Building flux capacity: Citizens scientists increase resolution of soil greenhouse gas fluxes. *PLOS ONE*. 13(7): e0198997. doi.org/10.1371/journal.pone.0198997.
90. Richter, A., Dörler, D., Hecker, S., Heigl, F., Pettibone, L., Serrano, F., et al. 2018. Capacity building in citizen science. In book: *Citizen Science – Innovation in Open Science, Society and Policy*. UCL Press, pp.269-283. DOI: 10.2307/j.ctv550cf2.26.
91. Ruggie, J. G. (2002). *The Theory and Practice of Learning Networks: Corporate Social Responsibility and the Global Compact*. JCC 5, pp. 27-36.
92. Ryan, S.F., Adamson, N.L., Aktipis, A., Andersen, L.K., Austin, R. Barnes, L. et al. 2018. The role of citizen science in addressing grand challenges in food and agriculture research. *Proc. R. Soc. B* 285: 20181977. doi.org/10.1098/rspb.2018.1977.
93. Sachs JD, Schmidt-Traub G, Mazzucato M, Messner D, Nakicenovic N, Rockström J. 2019. Six Transformations to achieve the Sustainable Development Goals. *Nat Sustain*. 2. p. 805–814.
94. Sachs JD. 2012. From millennium development goals to sustainable development goals. *Lancet*. 379: 2206–11. doi: 10.1016/S0140-6736(12)60685-0.
95. Salvia, A., Leal Filho, W., Brandli, L. and Griebeler, J. (2018). Assessing research trends related to Sustainable Development Goals: local and global issues. *JCLP*. DOI: 10.1016/j.jclepro.2018.09.242.
96. Sandelowski, M. (2000). Combining Qualitative and Quantitative Sampling, Data Collection, and Analysis Techniques in Mixed-Method Studies. *Res. Nurs. Health*, 23: 246-255. doi:10.1002/1098-240X(200006)23:3<246::AID-NUR9>3.0.CO;2-H.
97. Sandelowski, M. (2000). Combining Qualitative and Quantitative Sampling, Data Collection, and Analysis Techniques in Mixed-Method Studies. *Res. Nurs. Health*, 23: 246-255. doi:10.1002/1098-240X(200006)23:3<246::AID-NUR9>3.0.CO;2-H.
98. Scharlemann, J.P.W., Mant, R.C., Balfour, N., Brown, C., Burgess, ND., Guth, M., Ingram, DJ., Lane, R., Martin, J., Wicander, S., Kapos, V. (2016) *Global Goals Mapping: The Environment-human Landscape. A contribution towards the NERC, The Rockefeller Foundation and ESRC initiative, Towards a Sustainable Earth: Environment-human Systems and the UN Global Goals*. Sussex Sustainability Research Programme, University of Sussex, Brighton, UK and UN Environment World Conservation Monitoring Centre, Cambridge, UK.
99. Scholz, I., Keijzer, N., and Richerzhagen, C. 2016. Discussion Paper 13. Deutsches Institut für Entwicklungspolitik. https://www.diegdi.de/uploads/media/DP_13.2016.pdf (accessed on May 2019).
100. Schoonenboom, J., and Johnson, R.B. (2017) *Köln Z Soziol*, 69(Suppl 2): 107. doi.org/10.1007/s11577-017-0454-1.
101. Schoonenboom, J., and Johnson, R.B. (2017) *Köln Z Soziol*, 69(Suppl 2): 107. doi.org/10.1007/s11577-017-0454-1.
102. Science Europe. 2018. Briefing Paper on Citizen Science. D/2018/13.324/2 <https://www.scienceeurope.org/our-resources/briefing-paper-on-citizen-science> (accessed on August 2019).
103. SDSN Australia, New Zealand & Pacific Edition (2017) *Getting Started with the SDGs in Universities: A Guide for Universities, Higher Education Institutions, and the Academic Sector* www.ap-unsdsn.org/wp-content/uploads/2017/08/University-SDG-Guide_web.pdf (accessed on 10 July 2018).
104. Sedlacek, S. (2013). The role of universities in fostering sustainable development at the regional level. *JCLP*, 48, 74-84. doi.org/10.1016/j.jclepro.2013.01.029.
105. Shulla K, Leal Filho W, Lardjane S, Henning Sommer J, Lange Salvia A, Borgemeister C. 2019. The contribution of regional centers of expertise for the implementation of the 2030 Agenda for Sustainable Development. *JLCP*. 237. 117809.
106. Silvertown, J. 2009. A new dawn for citizen science. *Trends in ecology and evolution*. DOI: <https://doi.org/10.1016/j.tree.2009.03.017>.
107. Smith, E., Parks, S., Gunashekar, S., Lichten, C., Knack, A. and Manville C. 2017. *Open Science: The citizen's role and contribution to research*. Santa Monica, CA: RAND Corporation. <https://www.rand.org/pubs/perspectives/PE246.html>. (accessed on May 2019).
108. Societize. 2013. *Green Paper on Citizen Science*. European Commission. <https://ec.europa.eu/digital-single-market/en/news/green-paper-citizen-science-europe-towards-society-empowered-citizens-and-enhanced-research> (accessed on August 2019).

- 109.Socientize. 2014. White Paper on Citizen Science. European Commission. http://www.socientize.eu/sites/default/files/white-paper_0.pdf (accessed on August 2019).
- 110.Strasser, B. and Haklay, M. 2018. Citizen Science: Expertise, democracy, and public participation. Report to the Swiss Science Council.https://www.swir.ch/images/stories/pdf/en/SWR_PolicyAnalysis_CitizenScience_INHALT_EN_excerpt.pdf (accessed on August 2019).
- 111.Sustainable Development Knowledge Platform. (2014). Tenth session of the Open Working Group on Sustainable Development Goals. A definitional note on goals and targets. <https://sustainabledevelopment.un.org/owg10.html> (accessed on 13 July 2019).
- 112.Sustainable Development Knowledge Platform. <https://sustainabledevelopment.un.org/vnrs/> (accessed on 18 July 2018).
- 113.U.] United Nations. 2012. Future we want. <https://sustainabledevelopment.un.org/content/documents/733FutureWeWant.pdf>. (accessed 2019, November 1).
- 114.UN, United Nations. (2015). Transforming our world: the Agenda 2030 for Sustainable Development. A/RES/70/1.<https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf>. (accessed 2019, November 24).
- 115.UN, United Nations. 2015. Transforming our world: the 2030 Agenda for Sustainable Development. A/RES/70/1. <https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf>. (accessed 2019, November 24).
- 116.UN. United Nations. 1992. Agenda 21. <https://sustainabledevelopment.un.org/outcomedocuments/agenda21>. (accessed 2019, October 29).
- 117.UN. United Nations. 2015. Transforming our world: the 2030 Agenda for Sustainable Development. A/RES/70/1. <https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf>. (accessed 2019, November 2).
- 118.UN. United Nations. 2019. The future is now science for achieving sustainable development. Global sustainable development report. https://sustainabledevelopment.un.org/content/documents/24797GSDR_report_2019.pdf. (accessed 2019, November 7).
- 119.UNDESA, Department of Economic and Social Affairs, Statistics Division. <https://unstats.un.org/sdgs/iaeg-sdgs/tier-classification/> (accessed on 07 January 2019).
- 120.UNDESA. United Nations Department of Economic and Social Affairs, Statistics Division. 2017. <https://unstats.un.org/sdgs/dataContacts/>. (accessed 2019, November 2).
- 121.UNDESA. United Nations Department of Economic and Social Affairs, Statistics Division. 2019. <https://unstats.un.org/sdgs/iaeg-sdgs/tier-classification/>. (accessed 2019, January 7).
- 122.UNDP (2017). Institutional and Coordination Mechanisms; Guidance Note <http://www.undp.org/content/undp/en/home/librarypage/sustainable-development-goals/institutional-and-coordination-mechanisms---guidance-note.html> (accessed on 28 June 2018).
- 123.UNDP. 2017. Voluntary National Reviews and National SDG Reports. United Nations Development Programme. https://sustainabledevelopment.un.org/content/documents/16665Compilation_of_Executive_Summaries_2017_VNRs.pdf (accessed on August 2019).
- 124.UNESCO. (2018). Issues and trends in Education for Sustainable Development. <https://unesdoc.unesco.org/ark:/48223/pf0000261445> (accessed on 13 July 2019).
- 125.UNESCO. 2018. Issues and trends in education for sustainable development. <https://unesdoc.unesco.org/ark:/48223/pf0000261445> (accessed on 13 July 2019).
- 126.UNESCO. United Nations Educational, Scientific and Cultural Organization. 2009. Learning for a sustainable world: review of contexts and structures for education for sustainable development. www.unevoc.unesco.org/up/DESD_key_findings_and_way_forward_23March09.pdf. (accessed 2019, March 8).
- 127.UNESCO. United Nations Educational, Scientific and Cultural Organization. 2014a. Shaping the Future We Want: UN. Decade for Sustainable Development (2005-2014) Final Report. Paris, France. <https://sustainabledevelopment.un.org/content/documents/1682Shaping%20the%20future%20we%20want.pdf>. (accessed 2019, November 1).
- 128.UNESCO. United Nations Educational, Scientific and Cultural Organization. 2017. Education for Sustainable Development Goals Learning Objectives. https://www.unesco.de/sites/default/files/2018-08/unesco_education_for_sustainable_development_goals.pdf. Accessed 2019, November 2).

129. UNESCO. United Nations Educational, Scientific and Cultural Organization. 2018b. Issues and trends in Education for Sustainable Development, Leicht, A. Heiss, J. Byun, W. J., eds, ISBN 978-92-3-100053-9.
130. UNESCO. United Nations Educational, Scientific and Cultural Organization. 2019. SDG 4 - Education 2030: Part II, Education for Sustainable Development beyond 2019. <https://unesdoc.unesco.org/ark:/48223/pf0000366797.locale=en>. (accessed on 17 October 2019).
131. UNESCO. United Nations Educational, Scientific and Cultural Organization 2014b. Roadmap for Implementing the Global Action Programme on Education for Sustainable Development, <http://unesdoc.unesco.org/images/0023/002305/230514e.pdf> (accessed 8 March 2019).
132. UNESCO. United Nations Educational, Scientific and Cultural Organization. 2018a. Policy brief, Education for Sustainable Development and SDGs. https://en.unesco.org/sites/default/files/gap_pn1_-_esd_and_the_sdgs_policy_brief_6_page_version.pdf (accessed 2 March 2019).
133. UNESCO-UIS. United Nations Educational, Scientific and Cultural Organization Institute for Statistics. 2012. International Standard Classification of Education ISCED 2011, ISBN 978-92-9189-123-8 Ref: UIS/2012/INS/10/REV.
134. United Nations Global Compact (2017). Making Global Goals Local Business: A New Era for Responsible Business <https://www.unglobalcompact.org/library/4321> (accessed on 27 June 2017).
135. United Nations University, Institute of Advanced Studies (2010). Five Years of Regional Centres of Expertise on ESD. 124 pp. <https://www.rcenetwork.org/portal/sites/default/files/brochures/5%20years%20of%20RCEs.pdf> (accessed on 13 July 2019).
136. United Nations University, Institute of Advanced Studies (2014). Building a Resilient Future through Multi-stakeholder Learning and Action: Ten Years of Regional Centres of Expertise on Education for Sustainable Development, http://www.rcenetwork.org/portal/sites/default/files/public_resource/01_UNU_10yearsBook_web.pdf (accessed on 13 July 2019).
137. UNSSC. 2019. The 2030 Agenda for Sustainable Development. UNSSC Knowledge Centre for Sustainable Development. https://www.unssc.org/sites/unssc.org/files/2030_agenda_for_sustainable_development_kcsd_primer_en.pdf (accessed on August 2019).
138. UNU-IAS. United Nations University-Institute for Advanced Studies 2014. Building a Resilient Future through Multi-stakeholder Learning and Action: Ten Years of Regional Centres of Expertise on Education for Sustainable Development.
139. UNU-IAS. United Nations University-Institute for Advanced Studies. 2016. Climate Change Education: From Critical Thinking to Critical Action. Policy Brief. 4. 2016. <http://www.rcenetwork.org/portal/sites/default/files/UNU-IAS%20PB%204%20-%208FEB%20-%20for%20printing2.pdf> (accessed 2019, October 6).
140. UNU-IAS. United Nations University-Institute for Advanced Studies. 2018a. Academia and Communities: Engaging for Change Innovation in Local and Global Learning Systems for Sustainability Learning Contributions of the Regional Centres of Expertise on Education for Sustainable Development. file:///C:/Users/kshulla/Desktop/Academia_and_Communities_FINAL.pdf. (accessed on 20 October 2019).
141. UNU-IAS. United Nations University-Institute for Advanced Studies. 2018b. Ensure Healthy Lives and Promote Well-being for All Experiences of Community Health, Hygiene, Sanitation and Nutrition Learning Contributions of the Regional Centres of Expertise on Education for Sustainable Development. http://collections.unu.edu/eserv/UNU:6403/EnsureHealthyLives2018_ONLINE.pdf. (accessed on 20 October 2019).
142. UNU-IAS. United Nations University-Institute for Advanced Studies. 2018c. Good practices for esd: case reports from japanese rces. Accessed October 20 2019. <http://www.rcenetwork.org/portal/sites/default/files/GoodPracticesforESD%2020181203.pdf>
143. Vargas, V. R., Lawthom, R., Prowse, A., Randles, S., & Tzoulas, K. (2019). Sustainable development stakeholder networks for organisational change in higher education institutions: A case study from the UK. *JCLP*, 208, 470-478.
144. Wals A, Kieft G. 2010. Education for sustainable development research overview. <https://library.wur.nl/WebQuery/wurpubs/fulltext/161396>. (accessed 2019, October 2).
145. Wals AEJ, Mochizuki Y, Leicht A. 2017. Critical case-studies of non-formal and community learning for sustainable development. *Int Rev Educ*. 63: 783. <https://doi.org/10.1007/s11159-017-9691-9>.
146. Weitz N, Carlsen H, Nilsson M, Skanberg K. 2018. Towards systemic and contextual priority setting for implementing the 2030 Agenda. *Sustain Sci*. 13: 531.

147. Weitz, N., Carlsen, H., Nilsson, M., Skanberg, K. (2018). Towards systemic and contextual priority setting for implementing the 2030 Agenda. *Sustain Sci.* 13: 531. Doi: 10.1007/s11625-017-0470-0.
148. West, S. and Pateman, R. 2017. How could citizen science support the Sustainable Development Goals? Policy brief. Stockholm Environment Institute. <https://mediamanager.sei.org/documents/Publications/SEI-2017-PB-citizen-science-sdgs.pdf> (accessed on August 2019).
149. Wildschut, D. 2017. The need for citizen science in the transition to a sustainable peer-to-peer-society. *Futures.* doi.org/10.1016/j.futures.2016.11.010.
150. Yan, X., Lin, H. and Clarke, A. (2018). Cross-Sector Social Partnerships for Social Change: The Roles of Non-Governmental Organizations. *Sustainability.* 10, 558. doi.org/10.3390/su10020558.

7. Supporting information

1. Survey “Role of networks in SDGs implementation” (as Appendix. A in Chapter 2 and as Table 4, in Chapter 3)

Sections	Questions
1) RCEs and their involvement with SDGs,	<ol style="list-style-type: none"> 1. Where is your RCE located? <ul style="list-style-type: none"> • Africa and Middle East • Asia - Pacific • Europe • The Americas 2. What is your affiliated organization? <ul style="list-style-type: none"> • Educational Institution • Local Government • Central government • Business • Non-profit • Other 3. Thematic focus of your RCE belongs to? (Subdivision of the Goals according to the UNSSC list of Goals in questions 6) <ul style="list-style-type: none"> • MDG’s Unfinished Business (Goals 1-5) • New Areas; Water, Energy, Economic Growth, Industry, Inequality, Urbanization (Goals 6-11) • Green Agenda (Goals 12-15) • Governance (Goal 16) • Partnership (Goal 17) 4. Based on your opinion to what extend is your RCE involved with SDGs? 0 (Not involved) -1-2-3-4-5 (Strongly involved) 5. Do you deal with? <ul style="list-style-type: none"> • The 2030 Agenda For Sustainable Development, as a whole • Several Goals • Only Goal 4. Ensure inclusive and equitable quality education • Other 6. Please select which specific Goals <ul style="list-style-type: none"> • GOAL 1: No Poverty • GOAL 2: Zero Hunger • GOAL 3: Good Health and Well-being • GOAL 4: Quality Education • GOAL 5: Gender Equality • GOAL 6: Clean Water and Sanitation • GOAL 7: Affordable and Clean Energy • GOAL 8: Decent Work and Economic Growth • GOAL 9: Industry, Innovation and Infrastructure • GOAL 10: Reduced Inequality • GOAL 11: Sustainable Cities and Communities • GOAL 12: Responsible Consumption and Production • GOAL 13: Climate Action • GOAL 14: Life Below Water • GOAL 15: Life on Land • GOAL 16: Peace and Justice Strong Institutions • GOAL 17: Partnerships to achieve the Goal 7. Do you work with specific targets and indicators? There are 161 targets and 244 indicators approved (232, + 9 indicators repeat under 2 or 3 targets), classified into Tier I,II,III, on the basis of their level of methodological development and the availability of data at the global level. (if yes, please

name from the list <https://unstats.un.org/sdgs/indicators/indicators-list/>

- Yes
 - No
8. Please select which of SDG4 targets you work with? (7 outcome targets, 3 means of implementation)
- Target 4.1
 - Target 4.2
 - Target 4.3
 - Target 4.4
 - Target 4.5
 - Target 4.6
 - Target 4.7
 - Target 4.a
 - Target 4.b
 - Target 4.c
 - None
9. Is your RCE involved in?
- Research for SDGs?
 - Development projects for SDGs?
 - Advertising/Campaigning for SDGs?
10. In how many projects or actions? (Please divide according to question 9 if possible)
11. With how many partners for each? (Please mention the type of partner organizations if possible)
12. What kind of collaboration?
- RCE is leading the process
 - Horizontal consortium or bilateral
 - Vertical, depending on funding organization
13. In the light of 2030 Agenda, will your RCE undertake changes as?
- Expand number of partners
 - Change Leadership forms
 - Change governance structure
 - Adopt your programme and strategies to include the SDGs
 - No Changes
14. Are your affiliated organization or partners organizations independently involved in SDGs?
- Yes
 - No
 - Maybe

2) networks links within regions and countries

15. Is your RCE collaborating with other networks in your region, for the 2030 Agenda for Sustainable Development?
- Networks of the same type of organization (Ex. the networks of Educational institutions, universities or schools)
 - Multi-stakeholder Networks (ex. business, public institutions, civil society, communities, educational institutions etc)
 - Other
16. Are you part of the national review process of your country? As part of its follow-up and review mechanisms, the 2030 Agenda for Sustainable Development encourages member states to "conduct regular and inclusive reviews of progress at the national and sub-national levels, which are country-led and country-driven" <https://sustainabledevelopment.un.org/memberstates>
- Yes
 - No
 - Maybe
17. In country level, do you contribute in?
-

-
- National committees created by your central government for SDGs
 - Committees created by Responsible Ministries for SDGs
 - Local government's actions toward 2030 agenda
 - Monitoring and tracking of SDGs progress
 - Consultancy for SDGs to national/local gov.
 - Only for specific Goals of your focus. i.e SDG 4
 - Other:
18. Have your National/Local Government, allocated accessible funds for SDGs?
- Yes
 - No
 - Maybe

3) network links in the international context

19. Do you collaborate with international organizations or networks for SDGs?
EX. Sustainable Development Solutions Network, Global Compact, European Sustainable Development Network, UNDP, SDGs Watch, European Union Institutions, etc
- Yes
 - No
20. Within the RCE global network, do you collaborate for SDGs with?
- Other RCE-s for SDGs implementation
 - RCE coordination Center and UNU
 - RCEs within continental groups
21. Do you think RCEs involvement with SDGs should be?
- Top down process (from international or national level)
 - Bottom up (from individuals, organizations, local networks)
 - Focus oriented (only when intersected with your own thematic focus)

4) Barriers challenges and opportunities.

22. Your involvement with SDGs is compromised by?
- Lack of funds
 - Lack of resources and staff
 - Lack of time
 - Not on your focus
 - Lack of autonomy from affiliated organization
 - Your Government is not active in 2030 Agenda
 - You are not involved in national/ local Gov actions
 - Other
23. The informality of the networks can influence SDGs by?
- Foster collaboration
 - Undermine the process
 - Difficult to measure and evidence the work
 - Weakens the visibility
 - Passive contribution
 - Other:
24. Do you find the 2030 Agenda for Sustainable Development?
- A method to measure impact of your network and organization
 - Ambiguous about targets and indicators
 - Difficult to measure and scale down
 - Very useful for your work
 - A continuation of your work for MDG on ESD
25. Please add other problems/barriers for your involvement with SDGs
-

2. The most influencing and influenced Targets in the RCEs context, and selected Indicators (as Table 5, in Chapter 3)

	Targets		Indicators
	The most influencing		
17.14	Enhance policy coherence for sustainable development	17.14.1	Number of countries with mechanisms in place to enhance policy coherence of sustainable development
17.17	Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships Data, monitoring and accountability	17.17.1	Amount of United States dollars committed to public-private and civil society partnerships
17.16	Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries	17.16.1	Number of countries reporting progress in multi-stakeholder development effectiveness monitoring frameworks that support the achievement of the sustainable development goals
13.3	Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	13.3.1	Number of countries that have integrated mitigation, adaptation, impact reduction and early warning into primary, secondary and tertiary curricula
		13.3.2	Number of countries that have communicated the strengthening of institutional, systemic and individual capacity-building to implement adaptation, mitigation and technology transfer, and development actions
13.1	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	13.1.2	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030 (goal 1.5.3) (goal 11.b.1)
		13.1.3	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies (1.5.4) (11.b.2) (I)
17.6	Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge-sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism	17.6.1	Number of science and/or technology cooperation agreements and programmes between countries, by type of cooperation
12.8	By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	12.8.1	Extent to which (i) global citizenship education and (ii) education for sustainable development (including climate change education) are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment
12.1	Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries	12.1.1	Number of countries with sustainable consumption and production (SCP) national action plans or SCP mainstreamed as a priority or a target into national policies
12.b	Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products	12.b.1	Number of sustainable tourism strategies or policies and implemented action plans with agreed monitoring and evaluation tools
11.6	By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	11.6.1	Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities
15.c	Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities	15.c.1	Proportion of traded wildlife that was poached or illicitly trafficked (15.7.1)
11.3	By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries	11.3.1	Ratio of land consumption rate to population growth rate
		11.3.2	Proportion of cities with a direct participation structure of civil society in urban planning and management that operate regularly and democratically
7.a	By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and	7.a.1	International financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems

	cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology		
12.6	Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle	12.6.1	Number of companies publishing sustainability reports
	The most Influenced		
4.7	Education for sustainable development and global citizenship	4.7.1	Extent to which (i) global citizenship education and (ii) education for sustainable development, including gender equality and human rights, are mainstreamed at all levels in: (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment
3.d	Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks	3.d.1	International Health Regulations (IHR) capacity and health emergency preparedness
2.4	By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	2.4.1	Proportion of agricultural area under productive and sustainable agriculture
15.5	Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species	15.5.1	Red List Index
4.3	By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university	4.3.1	Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months, by sex
6.b	Support and strengthen the participation of local communities in improving water and sanitation management	6.b.1	Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management
6.6	By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	6.6.1	Change in the extent of water-related ecosystems over time
11.4	Strengthen efforts to protect and safeguard the world's cultural and natural heritage	11.4.1	Total expenditure (public and private) per capita spent on the preservation, protection and conservation of all cultural and natural heritage, by type of heritage (cultural, natural, mixed and World Heritage Centre designation), level of government (national, regional and local/municipal), type of expenditure (operating expenditure/investment) and type of private funding (donations in kind, private non-profit sector and sponsorship)
2.3	By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	2.3.1	Volume of production per labour unit by classes of farming/pastoral/forestry enterprise size
		2.3.2	Average income of small-scale food producers, by sex and indigenous status
7.3	By 2030, double the global rate of improvement in energy efficiency	7.2.2	Energy intensity measured in terms of primary energy and GDP

3. Summary of the survey instrument (as Appendix 1. in Chapter 4)

Survey: The role of Citizen Science for the Sustainable Development Goals	
1. Where are you located?	
2. What is your role in Citizen Science?	My organization involves citizens in scientific projects/initiatives; Part of CS national/international networks; Part of CS groups or a citizen's scientist; Policymaker; Not involved; Other
3. How do you align your CS work with the 2030 Agenda for Sustainable Development? (multiple answers possible)	Integrating SDGs to the CS existing projects; Working broadly on SDGs themes (i.e. health, water, biodiversity, education etc.); Align policies with SDGs; Not aligned with SDGs; Other
4. Do you identify your CS work with any specific Goals? (multiple answers possible)	List of the 17 SDGs and their descriptions
5. How do you participate in the SDGs processes? (multiple answers possible)	Through creating partnerships or collaborating with existing partnerships for SDGs; By participating in SDGs implementation processes, national local or international; By inviting CS groups or networks in national/local initiatives; Do not participate; Other
6. How can CS provide data for the SDG? (multiple answers possible)	Providing general data to fill the gaps of information; Mainly provide data for environmental indicators; Through UN statistical offices as 'non-official' data providers for the SDGs; Through national SDGs reporting and monitoring platforms; Other
7. What motivates CS to align with SDGs? (multiple answers possible)	Recognition; New partnerships; Financing opportunities; Other
8. What are the barriers and challenges for CS toward the SDGs? (multiple answers possible)	Lack of awareness toward SDGs; No infrastructure of involvement; Exclusiveness by institutions; Problems with data reliability, accuracy and ownership; Voluntary character of contributions; Other
9. According to your opinion, how can CS contribution toward the SDGs be increased? (multiple answers possible)	By representation in SDGs processes through organized national and international Citizen Science networks; By increasing engagement of citizens in science processes by institution and scientists; By increasing CS participation in thematic areas, as nature conservation, climate change, health, education etc.; By encouraging participatory governance and evidence-based policies; By establishing channels for data provision for SDGs by citizens; By enabling education, subject competence and empowerment of citizens; Other
10. Citizen Science cooperate between science, education and civic engagement, what elements of 2030 Agenda enforce that?	Educational element, including sustainable living and global citizenship; Participatory character; Collaboration and partnerships; Other
11. Please let us know if you have any comments or wish to add/highlight anything.	

4. Citizen Science networks, platforms and projects which received the survey (as Appendix 2. in Chapter 4)

Citizen Science Cost Action CA15212	https://www.cs-eu.net
European Citizen Science Association (ECSA)	https://ecsa.citizen-science.net/
WeObserve Project	https://www.weobserve.eu/
International Institute for Applied Systems Analysis (IIASA)	https://www.iiasa.ac.at/
EU-Citizen.Science project	http://eu-citizen.science/
Doing it Together Science	http://www.togetherscience.eu/
Australian Citizen Science Association (ACSA)	https://citizenscience.org.au/
Atlas of Living Australia	https://www.ala.org.au/
Stifterverband	https://www.stifterverband.org/veranstaltungen/2016_06_23_citizen_science
OpenAIRE	https://www.openaire.eu/

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- RCEs global network
- COST Action on Citizen Science, CA15212