Developing metrics and instruments to evaluate citizen science impacts on the environment and society

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List of Acronyms

CBM	Community-Based Monitoring
CERN	European Organization for Nuclear Research
CLI	Community Level Indicators
CO	Citizen Observatories
CoP	Community of Practice
CPI	Context, Process, Impacts
CS	Citizen Science
DEFRA	Department for Environment Food and Rural Affairs
DG-RTD	Directorate General for Research and Innovation
DMAIC	Define Measure Analyze Improve Control
EC	European Commission
EOSC	European Open Science Cloud
GIIN	Global Impact Investing Network
GRI	Global Reporting Initiative
GT2.0	Ground Truth 2.0
IA	Impact Assessment
IMP	Impact Management Project
IRIS	Impact Reporting and Investment Standards
ISE	Informal Science Education
KTD	Key Technology Domains
MoRRI	Monitoring the Evolution and Benefits of Responsible Research and Innovation
MoS	Measures of Success
NGO	Non-Governmental Organisation
NRC	National Research Council
NSF	National Science Foundation
OECD	Organisation for Economic Co-operation and Development
OPR	Open peer review
OSM	Open Science Monitor
PE	Public Engagement
PPPR	Post-publication Peer Review
PPSR	Public Participation in Scientific Research
RIA	Research and Innovation Action
RRI	Responsible Research and Innovation
SDGs	Sustainable Development Goals
SMART	Specific, Measurable, Achievable, Realistic, Time-dependent
STEM	Science Technology Engineering Maths
ToC	Theory of Change
UK	United Kingdom
URL	Uniform Resource Locator
US	United States
WP	Work Package

Executive Summary

The MICS project is tasked with setting up and implementing an Impact Assessment framework for citizen science projects that serves to capture impacts in five distinct domains: society, science, environment, economy and governance. This report is a deliverable of Work Package 2 (WP2) – 'Methods for measuring citizen-science impact' which provides the conceptual insights for the development of MICS approaches and tools to assess citizen-science impacts. The purpose of this report is to review relevant impact assessment frameworks, both general ones and those specific for Citizen Science, in order to generate insights for a consolidated MICS Impact Assessment framework. In order to inform the generation of this framework, we employed desk research as well as empirical research to capture insights from different sources. Specifically, we used desk research to review general impact assessment frameworks (nine in total) as well as CS-specific impact assessment frameworks (15 in total) and empirical research to tap into the current practices and insights of citizen science project coordinators (10 projects).

- Among the nine reviewed 'managing for impacts' frameworks, the Theory of Change stands out for its structure for both, impact assessment and guidance towards achieving impacts. It supports the design of impact pathways that cut across different impact domains and the specification of layered & related intermediary outcomes.
- The review of 15 citizen-science-focused IA (CS IA) approaches suggests that there is no single best practice among the reviewed CS IA approaches: the greater the strengths of a CS IA approach, the more resource-intensive it tends to be. It points to the need for a combination of data collection methods that draw on a variety of informants and sources, especially with the increasing coverage of several impact domains over time by subsequent approaches. It also generates a range of relevant insights, conceptual as well as methodological, that MICS can select from and build on, namely definitional systems (of outputs, outcomes and impacts in the several of the MICS domains) and templates, guidelines and methodological instructions. The call to the CS IA field to reflect on its own approaches aligns with the task of MICS: it needs to provide a citizen-science impact assessment framework that is built on the reflections generated by this literature and strives to provide a flexible yet standardised CS IA framework and methodology that citizen-science projects can use based on their available resources, yet generate comparable results across projects.
- The MICS empirical enquiry among citizen-science project coordinators investigated their current citizen science assessment approaches as well as their needs regarding impact assessment methods and tools. The analysis indicates the range of reasons (or purposes) for undertaking impact assessment of citizen-science initiatives, which range from the proposal stage to increasing levels of insight generation during and after project lifetimes. A range of IA methods is used, differing in terms of timing as well as structuring and capturing impacts. The impact indicators mentioned by the interviewed citizen-science practitioners reflect some blurring of definitions or distinctions of terminology but also the broad range of impact indicators in use, which include not only cognitive changes in awareness but also changes in attitudes, actions

and policy. The five impact domains that MICS is exploring were confirmed as relevant, albeit to differing degrees. A number of challenges for undertaking impact assessments of their citizen-science projects were identified, relating to the well-known dilemma of misalignment in terms of timing of funded project activities versus the (longer term) manifestation of envisaged (and observable) impacts; difficulties with collecting data about impacts; project priorities limiting attention to impact assessment activities; lack of competencies to undertake sound impact assessment among project partners; and unavailability of resources in terms of staff time.

These review results are used to produce guiding principles for the MICS Impact Assessment framework, covering the following aspects:

- Purpose of citizen-science impact assessment
- Non-linear impact journeys rather than impact silos
- IA data collection methods & information sources
- Relative vs absolute impact
- Comparison of IA results across citizen-science projects
- Cumulative enhancement of the framework over time

The resulting insights of this review will be used to construct a consolidated MICS Impact Assessment framework. A key characteristic of the MICS Impact Assessment framework is not only its conceptual grounding in latest insights, but its flexibility in terms of the *purpose* for which citizen science projects undertake impact assessment activities and the *resources* (means) that they have at their disposal. Providing flexibility for both aspects will maximise the usability of the MICS Impact Assessment framework – and therefore the *impact* that the MICS IA framework itself will have among the community of citizen science practitioners.

In the MICS case studies, we will 'practice what we preach' with respect to citizen science by involving the citizen scientists, community members and other stakeholders in each case study in the impact assessment activities. Arguably they are equally well - or even better - placed to inform and judge the evolving impacts of their citizen science activities. This involvement will entail the joint research agenda-setting (via the agreement of community-level indicators during the co-design process) as well as joint data collection, analysis and interpretation/identification of required action.

The methodological operationalisation of this framework will be detailed in the follow up deliverable D2.3 'Impact-assessment methods adapted to citizen science', due in June 2020. This will present the indicator framework in detail as well as the (different) methods for collecting data for each indicator.

1 Introduction

1.1 Background on MICS

The MICS project develops approaches and tools to assess citizen-science impacts. These approaches and tools can help to plan and implement projects in ways that lead to more robust results.

The MICS project specifically aims to:

- provide comprehensive, participatory and inclusive metrics and instruments to evaluate citizen science impacts;
- implement an impact-assessment knowledge-base through toolboxes for methods application, information visualisation, and delivery to decision makers, citizens and researchers;
- improve the effectiveness of nature-based solutions through test-site development and citizen-science tool validation;
- generate new approaches that strengthen the role of citizen science in supporting research and development;
- foster a citizen-science approach to increase the extent to which scientific evidence is taken up by policy makers through recommendations and guidelines.

The result is an integrated platform where these metrics and instruments are available for use by anyone involved in a citizen-science project wanting to understand its impact, whether at the planning stage or several years after the project's conclusion. This platform is validated by pilot testing in four test and validation sites across Europe. The four test and validation sites are in the UK, Italy, Hungary and Romania. These sites explore the applicability of MICS impact-assessment tools in regions with differing needs, contexts, and approaches to nature-based solutions, and with various levels of citizen-science application. For example, in Western Europe, river restoration is increasingly carried out within an ecosystem-based management framework at river or catchment scale; in Southern Europe, river restoration tends to be issue-specific with some ecosystem relevance; in Central and Eastern Europe, river restoration is about ecosystem protection and related to existing infrastructure.

1.2 Purpose

The MICS project is tasked with setting up and implementing an Impact Assessment framework for citizen science projects that serves to capture impacts in five distinct domains: society, science, environment, economy and governance. This report is a deliverable of Work Package 2 (WP2) – 'Methods for measuring citizen-science impact' which provides the conceptual insights for the development of MICS approaches and tools to assess citizen-science impacts. The purpose of this report is to review relevant impact assessment frameworks, both general ones and those specific for Citizen Science, in order to generate insights for a consolidated MICS Impact Assessment framework.

1.3 Structure of the report

This report is organised as follows. Following this introductory chapter, section 2 presents the approach used for structuring the review of impact assessment frameworks, drawing both on

secondary as well as empirical data consisting of 10 interviews. Section 3 shows the results of the review, summarising the findings of reviewing a selection of general, substantive impact assessment frameworks as well as the results of emerging impact assessment approaches focused on citizen-science. Section 4 concludes with an indication of which MICS tasks will capitalise on the results of this report.

2 Methods

In order to undertake a review of relevant impact assessment frameworks (general ones and those focused on Citizen Science) to inform the generation of the consolidated MICS Impact Assessment framework, we employed desk research as well as empirical research to capture insights from different sources. Specifically, we used desk research to review general as well as CS-specific impact assessment frameworks and empirical research to tap into the current practices and insights of citizen science project coordinators. More details are provided in the subsections below.

2.1 Review of impact assessment frameworks

The review of general impact assessment frameworks was based on a dedicated template in order to generate comparable insights of each framework. This template was based on an advanced version produced by the WeObserve Impact Community of Practice (CoP) in 2018 and which has been made available to the MICS project. The template by the WeObserve Impact CoP had been designed for the context of citizen observatories/citizen-science. The authors of this report (D2.2) adjusted the template for the purposes of MICS and generalised it to allow the review of more general impact assessment frameworks. Moreover, additions were made to i) capture the definition of impact, ii) the detailed methodological steps of the reviewed framework and iii) which impact domains it addresses (i.e. the MICS domains and/or others). The MICS version of the generic template is available in Annex 1. In summary, this template serves to capture the following information about the IA framework being reviewed: i) general information (name, reference, reviewer relationship, required inputs, conditions for the use of the method, intended users); ii) details about capturing impacts and value (purpose of the method, perspective of capturing impacts, types of impact domains/categories, definition of impact and value, detailed approached, assumptions of the method); iii) experience with applying the method (context of method use, strengths and weaknesses of the method, any other information).

This review covered nine substantial impact assessment frameworks. Four general impact assessment frameworks were mentioned in the MICS proposal, and include: MoRRI, IRIS, GRI and Open Science Monitor. Other relevant frameworks were identified during the inception period of the project (e.g. during the kick-off meeting in Delft, January 2019): Open Up Indicators, DEFRA indicators, Magenta Book, the Results chain framework and the Theory of Change. The full details of the review of these IA frameworks are included in Annex 2, while the analysis of the review results is presented in section 3.2.

2.2 Review of citizen-science impact assessment frameworks

The review of the citizen-science focused impact assessment frameworks is based on desk research of relevant literature. As this is an emerging field, the number of publications included in this review was limited (18 in total). The review included a conceptual basis, the impact domains covered, the details of the methodological approach for applied the conceptual framework (if available) and the strengths and weaknesses of the CS IA framework.

2.3 Small scale empirical research into current IA practice of citizen science project coordinators

The third source of information for this report consists of empirical material obtained via dedicated, semi-structured interviews with citizen-science project coordinators from the following projects:

- I-mars.eu
- Citclops
- Fresh Water Watch
- Naturehood
- D-NOSES
- Earth Challenge 2020
- Swedish Mass Experiment 2020
- Cities-Health
- Outfall Safari
- ACTION

Specifically, eleven interviews were held in Q1 2020 as a joint effort of MICS WP2 and WP3. The purpose of these interviews was to elicit their current citizen science assessment approaches as well as scoping their needs regarding impact assessment methods and tools, so that MICS can shape its impact assessment framework, tools and platform interfaces accordingly. The details of the interview protocol, as well as the interview transcripts, are presented in MICS deliverable D2.4. The results of these interviews were analysed for this report (using the MaxQDA software) with a view to identifying the purpose of impact assessment activities in their citizen-science projects, the methods and approaches currently used, impact indicators as well as impact domains of interest, as well as challenges encountered in assessing the impacts of their citizen science activities.

3 Results

3.1 Introduction

Impact assessment has evolved substantially over the past five decades. Impact assessments in the 1960s/70s used to have a particular thematic focus and were typically undertaken in isolation. For example, the early (1960s/70s) Environmental Impact Assessments (EIAs) were almost exclusively focused on the bio-physical environment. Subsequent integrated EIAs (late 2000s) encompass a more comprehensive understanding of impacts, including human health and safety, heritage assets and historical and cultural sites as well as livelihoods, lifestyle and well-being of those living in affected areas (UNEP, 2002). Parallel to this evolution towards more comprehensive, holistic IA approaches, citizen-science activities have grown exponentially (Kullenberg and Kasperowski, 2016). Citizen science activities constitute specific and recent phenomena that are triggering particular types of changes, such as innovative forms of public participation in flood risk management and water quality management, individual and collective behaviour change to reduce air quality pollution and new forms of stakeholder collaboration to balance sustainable livelihoods and biodiversity conservation (e.g. Wehn and Evers, 2015; Wehn et al., 2020). These changes are not yet easily or comprehensively captured by existing generic IA frameworks. The MICS project has been tasked with setting up and implementing an Impact Assessment framework for citizen science projects that serves to capture impacts in five distinct domains: society, science, environment, economy and governance. In this section, we analyse insights and knowledge that MICS can build on from the field (of what we refer to) as 'general impact assessment frameworks' (section 3.2), the emerging field of impact assessment within the science of citizen-science (section 3.3) as well as current practice tapped into via dedicated interviews with citizen science project coordinators (section 3.4). In section 3.5, we combine these into guiding principles for the MICS Impact Assessment framework of citizen-science.

3.2 General Impact Assessment Frameworks

The general impact assessment frameworks we reviewed include MoRRI, IRIS+, GRI and Open Science Monitor; Open Up Indicators, DEFRA indicators, Magenta Book, the Results chain framework and the Theory of Change. In this section, we present the analysis of the review results (Table 1); the full details of the review of each of these IA frameworks are included in Annex 2.

The reviewed frameworks can be grouped into the following clusters: accounting frameworks, frameworks for managing towards impact, and those focused on generating scientific knowledge and insights for particular audiences (e.g. policy makers).

The accounting frameworks (GRI and Magenta Book) are both very comprehensive, but, as the category name implies, they are 'single purpose' in that they are designed for accounting purposes only. Moreover, their comprehensiveness comes at the price of being demanding.

The 'managing for impacts' frameworks are more appropriate for the dual purpose of IA in MICS, i.e. capturing impacts for both, accounting and learning purposes to advise citizen-

science projects how to achieve their envisaged impacts. While all three - IRIS+, the Results Chain Framework and the Theory of Change – provide conceptual clarity, the Theory of Change stands out for its structure for both, impact assessment & guidance towards achieving impacts, the ability to design and capture impact pathways that cut across different impact domains and the specification of layered & related intermediary outcomes.

The IA frameworks for generating scientific knowledge do not provide an overarching IA framework for MICS per se; however, they provide sources of definitions of distinct indicators in specific domains of interest for MICS (e.g. Open Science Monitor for the science impact domain; MoRRI indicators for selected impact domains (society, science, governance)) (see

Table 2).

Table 1 Analysis of selected general impact assessment frameworks

Title	Purpose/ area of application	Strengths(+) & weaknesses (-)	Relevance for MICS
Accounting frameworks			
GRI	Public sustainability reporting by organisations	+ comprehensive + standardised - voluntary - unclear - demanding	*Selected indicators in specific domains*
Magenta Book	Evaluation of policies, projects, interventions *[process evaluation change evaluation cost/benefit evaluation]*	+ detailed guidelines - too demanding to fully complete	*Steps of the evaluation cycle* *Detailed guidance in cost/benefit evaluation*
Managing towards impact			
IRIS+	Inform capital allocation decisions	+ linked to global of Community of Practice - focused on outputs more than outcomes & impacts	*Steps for impact measurement & management* *5 Impact dimensions and 16 categories of data to assess the impact performance*
Results chain framework	Interventions, projects *[causal sequence from cause to effect]*	+ specifies intervention & assumptions - too linear, hides non-linear/complex dynamics - no specification of scope/quality of impacts	*Distinction & links of inputs, activities, outputs, outcomes, impacts*
Theory of Change	Design/review of interventions, projects to promote social change Multi-actor collective impact monitoring[1]	+ articulation of clear and testable hypothesis about how change will occur + blueprint for evaluation with measurable indicators of success identified + track progress towards the end goal - challenge of articulating aspirational goals - difficulty in establishing clear boundaries for the ToC	*Provides structure for both, impact assessment & guidance towards achieving impacts* *Impact pathways that cut across different impact domains* *Specification of layered & related intermediary outcomes*
Scientific knowledge generation			
MoRRI	Monitoring system of actual practice of Responsible Research and Innovation (RRI) *[inform policy makers in EC DG-RTD]*	+ indicators both, outcomes and processes for achieving outcomes + RRI concept has gained momentum	*Distinction between process, outcome and perception-related indicators*

[1] Programme or Project Design, Review and/or quality audit of an existing initiative, Strategic learning design and knowledge generation, evaluation, multi-actor collaboration and collective impact monitoring, scaling up and scaling out

Title	Purpose/ area of application	Strengths(+) & weaknesses (-)	Relevance for MICS
		- extensive data requirements - conceptual clash: citizen-science as example of process indicator of public engagement	*Indicators for selected impact domains [science, society, governance]*
Open Science Monitor	Generate insights on the ongoing development of open science practices *[inform EC policy on Open Science]*	+ broad range of indicators + draws on variety of data sources - not to be used as an (impact) assessment tool	*Distinction of supply, uptake and reuse of scientific outputs [Science impact domain]*
OpenUp	Foster research life cycle that is fit to support & promote Open Science	+ new platform offering a series of new impact data services - limited to one MICS impact domain (science)	*Impact metrics [Science impact domain]*
DEFRA indicators	Assess environmental impact at the national scale *[inform UK policy makers]*	+ provides rigorous methods for assessing impact on biodiversity - resource-intensive data collection - does not capture impact of a single policy or project - measures change in biodiversity at national scale	*Limited relevance; potentially biodiversity-related indicators [Environment impact domain]*

Table 2 Impact domain(s) covered by the reviewed Impact Assessment frameworks

General Impact Assessment framework	Impact domains				
	Society	Science	Economy	Environment	Governance
GRI	✓		✓	✓	✓
Magenta Book					✓
IRIS+	✓		✓	✓	
Results chain framework	✓		✓	✓	
Theory of Change	✓		✓	✓	✓
MoRRI	✓	✓			✓
Open Science Monitor	✓	✓			
OpenUp		✓			
DEFRA indicators	✓	✓	✓	✓	
Total Count	7	4	5	5	4

3.3 Impact assessment in the Citizen Science literature

In the science of citizen-science field, a number of contributions either propose an IA framework or methodology or discuss the topic of IA at length. We reviewed contributions that have been made to this literature during the last 13 years (i.e., since 2008) which resulted in a selection of 17 publications/project reports. The reviewed CS IA approaches are presented in Annex 3. Here we summarise the main results of interest to MICS: i) key methodological details, strengths & weaknesses, lessons learned as well as specific relevant insights for MICS (Table 3 Analysis of citizen-science focused Impact Assessment approaches: methodologies, strengths & weaknesses and lessons learned) and ii) the range of impact domains covered by each CS IA approach (see

Table 4).

These results reveal how the thinking about impact assessment of Citizen Science projects has evolved during the past (almost) decade and a half. From Table 4, it is evident that societal and science-related results of Citizen Science projects have received a lot of attention in this literature, while the focus on broader environmental, economic and governance-related impacts of citizen-science projects has been both, more limited and more recent.

In terms of methodological approaches, all of these CS IA approaches rely on quantitative as well as qualitative data, collected typically via a range of data collection methods. Surveys, interviews and focus group discussions are the most common method of CS IA. Eight of the CS IA approaches (Table 3) use combinations of the different data collection methods (Friedman, 2008; National Research Council, 2009; Bonney et al., 2009a; Bonney et al., 2009b; Phillips et al., 2012, 2014 and 2018; Kieslinger et al., 2017 and 2018; Wiggins et al.; 2018; Gharesifard et al., 2019 a & b; Wehn et al., 2017, 2019 and 2020), the last two of which are explicit about involving participants as well as other stakeholders as information sources. Two approaches depend only on one data collection method: interviews (Schäfer and Kieslinger, 2016) and field reports by principal investigators (Chandler et al., 2017). Several approaches are less explicit on the source of data for their approach (Shirk et al., 2012; Jordan et al. 2012; Bonney et al. 2014). Strikingly, only the Community Level Indicators approach explicitly relies on inputs from citizen scientists themselves in order to capture evolving impacts of the citizen-science project they are participating in. Overall, this points to the need for a combination of data collection methods that draw on a variety of informants and sources, especially with the increasing coverage of several impact domains over time by subsequent approaches.

In terms of strengths and weaknesses, the review suggests that there is no single best practice approach among the reviewed CS IA approaches. The strongest CS IA's are often the most resource-intensive. This is the case for the comprehensive Ground Truth 2.0 CS IA framework and methodology (Wehn et al., 2017, 2019, 2020) and the Context-Process-Impact (CPI) framework (Gharesifard et al., 2019a,b). The lessons learned from the CS IA approaches also confirm the need for flexibly tailoring CS IA according to various parameters (e.g. purpose of IA, available resources of a citizen-science project) while striking a balance with issues such as consistency for comparability across projects, not least to avoid unjust comparisons. This literature clearly supports a rationale for comprehensive rather than simplistic approaches in order to do justice to the nested nature and interdependency of evolving impacts across impact domains (Wehn et al., 2020; Gharesifard et al., 2019 a,b). Some stress the interconnectedness of outcomes, vested interests and design choices over time (e.g. Shirk et al., 2012) which has implications for how CS IA is and should be undertaken. The call for the CS IA field itself to reflect on its own approaches (e.g. Phillips et al., 2018) aligns with the task of MICS: it needs to provide a citizen-science impact assessment framework that is built on the reflections generated by this literature and strives to provide a flexible yet standardised CS IA framework and methodology that citizen-science projects can use based on their available resources, yet generate comparable results across projects.

Finally, the review of these CSI IA approaches also points to a range of relevant insights, conceptual as well as methodological, that MICS can select from and build on, namely definitional systems (of outputs, outcomes and impacts in the several of the MICS domains) and templates, guidelines and methodological instructions.

Table 3 Analysis of citizen-science focused Impact Assessment approaches: methodologies, strengths & weaknesses and lessons learned

Reference	Methodological approach to capturing CS impacts	Strengths (+) & weaknesses (-) of approach	Lessons learned/ Relevance for MICS
Informal Education and Outreach Framework Friedman (2008)	**Data collection:** (Online) surveys, review of project documentation, self-reported information by participants **Data type(s):** Quantitative & qualitative data	+ Elaborate on individual impact categories + Examples of impact evaluation for various program areas of informal science education + Clear distinction between outputs, outcomes & impacts - Not applicable to impact assessment beyond individual learning	**Lessons learned** There is no blueprint for impact assessment. Every project needs to find an impact assessment design which provides the most reliable analysis while making the most efficient use of finite resources (time and money). **Relevance for MICS** Six sub-categories of impact on society at the individual level
Strands of science learning National Research Council (2009)	**Data collection:** Surveys, interviews, focus group discussions **Data type(s):** Quantitative & qualitative data	+ Elaborate on individual impact categories (with a focus on Learning Science in Informal Education) + Includes guidelines on methods for researching each strand of science learning. - Not applicable to impact assessment beyond individual learning	**Lessons learned** [The lessons learned are mainly relevant for education program designers.] **Relevance for MICS** Six sub-categories of impact on society at the individual level
Triple C Bonney et al. (2009a)	**Data collection:** Surveys, interviews, focus group discussions **Data type(s):** Quantitative & qualitative data	+ Elaborate on individual impact categories + Empirical insights from application of the approach for IA of ten PPSR projects - Not applicable to impact assessment beyond individual learning - Requires detailed inputs	**Lessons learned** Impact assessment of past CS project often requires inputs that are not readily available. **Relevance for MICS** Six sub-categories of impact on society at the individual level and examples of indicators
Tool for Expanding Science Knowledge & Scientific Literacy Bonney et al. (2009b)	**Data collection:** Pre- and post-project surveys, self-reported knowledge gains among participants, analysis of communications with participants (e.g. emails), focus groups, interviews **Data type(s):** Quantitative & qualitative data	+ Clear indicators for societal and scientific impacts of CS projects - The scope of the paper is very wide and have limited focus on the impact assessment of CS	**Lessons learned** Evaluations can illuminate how to improve the project or how to design better projects in the future **Relevance for MICS** Two meta categories of outcomes for CS projects and seven indicators per category

Reference	Methodological approach to capturing CS impacts	Strengths (+) & weaknesses (-) of approach	Lessons learned/ Relevance for MICS
Generic logic model for describing results of PPSR Phillips et al. (2012; 2014; 2018)	**Data collection:** Surveys, interviews, focus group discussions, Observations, Tracking and timing, etc. **Data type(s):** Quantitative & qualitative data	+ Guidelines for different phases of evaluation (planning, implementation and sharing the results) + Useful templates for organizing impact assessment, data collection, etc. + clear distinction between outputs, outcomes & impacts - Focus only on learning outcomes	**Lessons learned** As the field of CS continues to grow, it is important to reflect on its relative impact, and to evaluate whether appropriate questions are being asked by qualified researchers working across projects that involve diverse audiences and issues. **Relevance for MICS** Practical guidelines and templates for designing, implementing and sharing CS impact assessment
5 Cs Shirk et al. (2012)	**Data collection:** Not specified, but the paper is based on five synthesis studies **Data type(s):** Quantitative & qualitative data	+ Considers four categories of outcomes and impact, including socio-ecological systems that are related to governance aspects + Clear distinction between outputs, outcomes & impacts - Application of the framework is resource-intensive	**Lessons learned** Certain outcomes may reinforce certain interests—and therefore particular design emphases—as initiatives evolve over time **Relevance for MICS** Four outcome and impact domains and 11 sub-domains
Framework for evaluation of citizen-science programs Jordan et al. (2012)	**Data collection:** Not specified **Data type(s):** Quantitative & qualitative data	+ Considers broader programmatic and community-level outcomes of CS projects. - The proposed framework is merely a list of possible domains and indicators - No information on how the proposed framework should be applied	**Lessons learned** Evaluation of learning outcomes of CS has become increasingly prioritized, while other, more far-reaching community-level outcomes have received less attention. **Relevance for MICS** Three categories and 19 sub-categories of outcomes and impacts for CS projects
Next steps for Citizen Science Bonney et al. (2014)	**Data collection:** Not explicitly specified, but there are references to project documentation and open-source data **Data type(s):** Quantitative & qualitative data	+ Considers broader social and environmental impacts of CS projects - The main focus is not on impact assessment or providing IA frameworks	**Lessons learned** Understanding the impact of CS projects can be challenging because of the diversity of projects

Reference	Methodological approach to capturing CS impacts	Strengths (+) & weaknesses (-) of approach	Lessons learned/ Relevance for MICS
Diversity of Citizen Science Schäfer and Kieslinger (2016)	**Data collection:** Interviews **Data type(s):** Quantitative & qualitative data	+Distinction between scientific, societal and environmental impacts - The focus of this paper is not on impact assessment of CS	**Lessons learned** There is a need for flexible impact assessment criteria and strategies that can be adapted to a large number of projects. **Relevance for MICS** Three impact domains and their link to the typologies of CS projects
Measures of Success Chandler et al. (2017)	**Data sources:** Field reports submitted by Principal Investigators **Data type(s):** Quantitative & qualitative data	+ Clear scoring rubric for each of the indicators + Lessons learned from applying the method to 51 projects - A review of the 12 MoS criteria revealed inconsistencies in how variables were interpreted by those scoring the projects. - Designed for a very specific type of projects - Limited number of indicators	**Lessons learned** Projects were unable to report many outcomes during the first two years of the project's duration. Users had different interpretations of using the MoS categories of impact **Relevance for MICS** Five categories and 12 subcategories of impact
Community-level indicators Woods et al. (2015)	**Data sources:** Citizen scientists' self-reports via surveys, focus groups, journaling, public data sources **Data type(s):** Mostly quantitative (also qualitative) data	+ Evaluation firmly rooted in target community + Co-design of evaluation questions & indicators (collective focus) + Bottom up tracking of impact evidence + Joint interpretation of results (creation of meaning) - Linear thinking underlying change model - Several conceptual weaknesses (blurred lines between CS and IA; overlapping CLI usage categories, internal & external indicators)	**Lessons learned** Difficulties of combining and aligning project-driven and community interests **Relevance for MICS** Citizen science-based IA integrated from the start of CS co-design
Outcomes of Citizen Science initiatives	**Data collection:** Online surveys, usage statistics, interviews, focus groups, etc.	+ Distinction between process evaluation and impact-related criteria	**Lessons learned** Evaluation instruments need to be embedded in a solid evaluation plan tailored for each project that

Reference	Methodological approach to capturing CS impacts	Strengths (+) & weaknesses (-) of approach	Lessons learned/ Relevance for MICS
Kieslinger et al. (2017; 2018)	**Data type(s):** Quantitative & qualitative data	+ Provides examples of evaluation criteria and supporting questions - Mix of outputs, outcomes and impacts in the proposed categories	may include concrete benchmarking of measurable targets to assess success during and after the project. **Relevance for MICS** Three impact categories and nine sub-categories
Science products of Citizen Science projects Wiggins et al. (2018)	**Data collection:** Project documentation, tools, publications **Data type(s):** Quantitative & qualitative data	+ Detailed categories and indicators of scientific outputs - Only focuses on science products of CS initiatives - Relied on an expert panel to develop and prioritize categories - Mix of outputs, outcomes and impacts terminology	**Lessons learned** Impact assessment must be used judiciously to prevent unintended 'apples and oranges comparisons' across projects. Productivity measures should be interpreted with care, because their value varies by context and purpose. **Relevance for MICS** Four categories and 19 sub-categories of scientific outputs and outcomes
CPI framework [Context - Process – Impact] Gharesifard et al. (2019 a,b)	**Data collection:** Interviews, observations, project documentation, CS tool analysis **Data type(s):** Quantitative & qualitative data	+ Comprehensive and considers multiple categories of impact + Clear distinction between outputs, outcomes & impacts - Application of the framework is resource-intensive	**Lessons learned** Impact categories are interdependent and overlap, therefore should not be studied independently **Relevance for MICS** Five relevant impact domains with examples of impact indicators
Ground Truth 2.0 Impact Assessment framework & methodology Wehn et al. (2017, 2019, 2020)	**Data collection:** Interviews & questionnaires with participants & other stakeholders; workshops with participants; project documentation, observations, CS tool analysis **Data type(s):** Quantitative & qualitative data	+ Comprehensive and thorough methodology, applied in six countries and CS initiatives with distinctly different thematic foci + Clear distinction between outputs, outcomes & impacts + Considers multiple categories of impacts - Application of the methodology is resource-intensive	**Lessons learned** The nested nature and slow evolution of changes across impact domains. Usefulness of measuring impacts against locally-defined CS objectives to generate insights on future trends and trajectories. **Relevance for MICS** Four relevant impact domains with seven sub-domains and 40 indicators with accompanying data collection instructions

Table 4 Impact domain(s) covered by the reviewed citizen-science Impact Assessment approaches

Citizen-science Impact Assessment approach	Impact domains				
	Society	Science	Economy	Environment	Governance
Informal Education and Outreach Framework	✓				
Strands of science learning	✓				
Triple C	✓				
Tool for Expanding Science Knowledge & Scientific Literacy	✓	✓			
Generic logic model for describing results of PPSR	✓				
5 Cs	✓	✓		✓	
Framework for evaluation of citizen-science programs	✓	✓	✓		
Next steps for Citizen Science	✓	✓		✓	
Diversity of Citizen Science	✓	✓		✓	
Measures of Success	✓	✓		✓	✓
Community Level Indicators	✓			✓	✓
Outcomes of Citizen Science initiatives	✓	✓	✓	✓	
Science products of Citizen Science projects		✓			
CPI Framework	✓	✓	✓	✓	✓
Ground Truth 2.0 framework & methodology	✓		✓	✓	✓

3.4 Results of MICS empirical enquiry into Citizen Science Impact Assessment

In this section, we review the results of the MICS empirical enquiry among citizen-science project coordinators, investigating their current citizen science assessment approaches as well as scoping their needs regarding impact assessment methods and tools.

The results of the coding of the interview transcripts are presented in Table 5. These indicate the range of reasons (or purposes) for undertaking impact assessment activities on citizen-science initiatives, which range from the proposal stage to increasing levels of insight generation: whether for personal/internal purposes (learning), feeding the promotion of the citizen science initiative (advertising/promotion), accounting or reporting (e.g. to funders or financial accountants), or even for improving project activities and the attainment of envisaged results and impacts via adaptive management (project evaluation and improvement).

Similarly, the interviews indicate a range of methods are used, differing in terms of timing (e.g. ex ante impact assessment before either the start of the project or the hands-on citizen-science activities on the ground) as well as structuring and capturing impacts (e.g. capturing

narrative impact stories vs structured surveys or interviews with a range of stakeholders, or analysing the usage of citizen-science tools).

Table 5 Coding results of MICS enquiry among citizen-science practitioners

Code System		Coded Segments	Documents
		158	**11**
Purpose of impact assessment			
	Project proposal justification	6	6
	Learning purposes	5	5
	Advertising, promotion & outreach	3	3
	Accounting/Reporting purposes	10	8
	Project evaluation and improvement	2	1
Methods of impact assessment			
	Logic framework (Impact Journey)	3	1
	Impact stories	5	5
	Impact value chain	1	1
	Cost/benefit analysis	1	1
	Surveys, interviews & feedback forms	12	9
	Statistics on tool usage	8	5
	Ex ante impact assessment	3	3
Impact indicators			
	Data points collected	9	8
	Data quality	3	3
	Citizens involved	9	6
	Attitudes changed	7	5
	Actions taken	2	2
	Policies changed	2	2
	Papers published	2	2
	Awareness raised	5	4
	Media attention	1	1
Impact Domains			
	Society	7	5
	Science	7	6
	Economy	3	3
	Environment	5	5
	Governance	5	4
Challenges for impact assessment			
	Timeline: project activities vs. impact manifestation	4	3
	Collection of impact data	5	4
	Project priorities	5	3
	Competence	2	2
	Availability of resources	1	1

The impact indicators mentioned by the interviewed citizen-science practitioners reflect some blurring of definitions or distinctions of terminology, e.g. referring to data points collected (arguably these are outputs, not impacts). Nevertheless, the responses indicate the broad range of impact indicators in use, which include not only cognitive changes in awareness but also changes in attitudes, actions and policy.

The five impact domains that MICS is exploring were confirmed as relevant, albeit to differing degrees by the respective respondents. Finally, a number of challenges for undertaking impact assessments of their citizen-science projects were identified, relating to the well-known dilemma of misalignment in terms of timing of funded project activities versus the (longer term) manifestation of envisaged (and observable) impacts; difficulties with collecting data about impacts; project priorities limiting attention to impact assessment activities; lack of competencies to undertake sound impact assessment among project partners; and unavailability of resources in terms of staff time.

3.5 Guiding principles for the MICS Impact Assessment framework

The analysis of the review results of general impact assessment frameworks (section 3.2), of IA frameworks tailored to citizen-science (section 3.3) and the approaches and demands from citizen-science practitioners (section 3.4) generates a number of salient insights that we use here to produce guiding principles (see Table 6) for the MICS Impact Assessment framework, covering the following aspects:

- Purpose of citizen-science impact assessment
- Non-linear impact journeys rather than impact silos
- IA data collection methods & information sources
- Relative vs. absolute impact
- Comparison of IA results across citizen-science projects
- Cumulative enhancement of the framework over time.

Table 6 Guiding principles for the MICS CS IA framework

Key aspect	Description	Guiding principle for MICS CS IA framework
Purpose of citizen-science impact assessment	The reasons for impact assessment of citizen-science projects differ from 'mere' impact reporting to learning for improved (future) implementation and even ex ante IA to substantiate proposal and grant applications.	The MICS CS IA framework needs to be able to accommodate a range of reasons, purposes and timing of undertaking IA of citizen-science projects. This requires the provision of process as well as results-related indicators, benchmarks and feedback on the extent to which and the ways in which envisaged results are and can be achieved, feeding into the adaptive management of citizen-science projects.
Non-linear impact journeys rather than impact silos	The limitations of linear conceptualisations of the logic framework are increasingly evident, including in the citizen-science field. Moreover, evidence from citizen-science impact assessments has shown that impact journeys are not linear within domains but that they 'zigzag' *across* domains.	The MICS CS IA framework needs to provide sufficient flexibility in the selection of relevant impact domains and respective intermediary outcomes. Users need to be able to *plan and trace impact pathways in and across the MICS domains (*society, economy, environment, governance, and science). For this, sound distinctions between outputs, outcomes and impacts in each domain are essential; moreover, causal relations not only between intermediary outcomes and impacts within a given domain but also *between outcomes in different* domains have to be identifiable and traceable. Similarly, it needs to be possible to select and adjust over time which SDGs the citizen-science project intends and actually contributes to
IA data collection methods & information sources	Sound IA of citizen-science projects involves a range of data collection methods and ideally includes not only participants but relevant stakeholders and beneficiaries who can provide evidence of (evolving) impacts.	The way in which users provide evidence needs to allow and guide them within a wide range of suitable IA data collection methods and stakeholders to be involved, but without being prescriptive. Moreover, data collection for impact assessment of citizen-science activities under the MICS CS IA framework should allow its users to 'practice what we preach' by involving citizen scientists in the collection of evidence about emerging impacts (e.g. the CLI approach), entailing measurement not only against 'scientific' indicators but also against community-defined success.
	Citizen-science projects have different resources (financial, time, qualified staff) at their disposal for their IA efforts which affect the extent of their IA efforts and hence the type and range of evidence that they can provide.	The MICS CS IA framework should provide sufficient and appropriate guidance, instructions as well as links to relevant resources to support IA data collection efforts of CS projects.
Relative vs absolute impact	The limitations of sticking to absolute and fixed measures of impact (typically quantified) are becoming increasingly evident,	The MICS CS IA framework needs to provide the means to enter and measure progress against project-specific objectives and taking contextual realities into account (geographical, socio-

Key aspect	Description	Guiding principle for MICS CS IA framework
	including in the field of citizen science. Sound IA needs to measure the impact relative to the context and the goals and objectives of citizen science projects.	economic setting, resources available (time, financial, staff, etc.)).
Comparison of IA results across citizen-science projects	The diversity of CS projects in terms of thematic issues addressed, stakeholders involved, extent and type of IA undertaken, etc., can make it challenging to compare results across projects.	The MICS CS IA can provide room for comparability of IA results that are based on different methods and information sources by using consistent overarching categories of definitions but distinguishing *confidence levels* (or similar, e.g. via a colour scheme) that stem from and indicate the (limited) range of underlying data sources. This can serve to generate individual as well as aggregate results.
Cumulative enhancement of the framework over time	The collective advancement of impact assessment theory and practice in the field of citizen science relies on reflection and cumulative additions, based on insights across projects and methods.	In order to remain relevant over time and serve the CS IA community, the MICS CS IA needs to be built on collective and cumulatively evolving intelligence, based on additional user inputs and definitions as well as more structured reflection and quality control (peer review) to check whether appropriate items/definitions/methods are being used.

4 Conclusions

This report has presented a review of impact assessment methods relevant for MICS, both general ones and those specific for Citizen Science. The resulting insights of this review will be used to construct a consolidated MICS Impact Assessment framework. As indicated in this report, a key characteristic of the MICS Impact Assessment framework is not only its conceptual grounding in latest insights, but its flexibility in terms of the *purpose* for which citizen science projects undertake impact assessment activities and the *resources* (means) that they have at their disposal. Providing flexibility for both aspects will maximise the usability of the MICS Impact Assessment framework – and therefore the *impact* that the MICS IA framework itself will have among the community of citizen science practitioners.

The MICS tasks and deliverables that will build on the results of this report are as follows:

- **Task 2.3** Establishment of a methodology and indicators for the citizen-science impact assessment of the pilot in each target region
    - **Deliverable D2.3** Impact-assessment methodology and indicators for citizen- science research ready to be used in the toolbox
- **Task 3.2** Tools for measuring the impact of citizen science
- **Task 3.3** Production of a citizen-science toolbox
    - **Deliverable D3.2** Toolbox for citizen- science research: accompanying documentation report
- **Task 4.1** Co-designing hands-on Citizen Science activities in the MICS case studies

The methodological operationalisation of this framework will be detailed in the follow up deliverable D2.3, due in June 2020. This will present the indicator framework in detail as well as the (different) methods for collecting data for each indicator.

In the MICS case studies, we will 'practice what we preach' with respect to citizen science by involving the citizen scientists, community members and other stakeholders in each case study in the impact assessment activities. Arguably they are equally well - or even better placed - to inform and judge the evolving impacts of their citizen science activities. This involvement will entail the joint research agenda-setting (via the agreement of community-level indicators during the co-design process) as well as joint data collection, analysis and interpretation/identification of required action.

References

Bonney, R., Ballard, H., Jordan, R., McCallie, E., Phillips, T., Shirk, J., & Wilderman, C. C. (2009). Public Participation in Scientific Research: Defining the Field and Assessing Its Potential for Informal Science Education. A CAISE Inquiry Group Report. Online Submission.

Bonney, R., Cooper, C. B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K. V., & Shirk, J. (2009). Citizen science: a developing tool for expanding science knowledge and scientific literacy. BioScience, 59(11), 977-984.

Bonney, R., Shirk, J. L., Phillips, T. B., Wiggins, A., Ballard, H. L., Miller-Rushing, A. J., & Parrish, J. K. (2014). Next steps for citizen science. Science, 343(6178), 1436-1437.

Chandler, M., Rullman, S., Cousins, J., Esmail, N., Begin, E., Venicx, G., . . . Studer, M. (2017). Contributions to publications and management plans from 7years of citizen science: Use of a novel evaluation tool on Earthwatch-supported projects. Biological Conservation, 208, 163-173. doi:https://doi.org/10.1016/j.biocon.2016.09.024

Friedman, A. J. (Ed.) (2008). Framework for evaluating impacts of informal science education projects. Report from a National Science Foundation Workshop. . Washington, DC: National Science Foundation.

Gharesifard, M., Wehn, U., & van der Zaag, P. (2019a). What influences the establishment and functioning of community-based monitoring initiatives of water and environment? A conceptual framework. Journal of Hydrology, 579, 124033. doi:https://doi.org/10.1016/j.jhydrol.2019.124033

Gharesifard, M., Wehn, U., & van der Zaag, P. (2019b). Context matters: a baseline analysis of contextual realities for two community-based monitoring initiatives of water and environment in Europe and Africa. Journal of Hydrology, 124144. doi:https://doi.org/10.1016/j.jhydrol.2019.124144

Jordan, R. C., Ballard, H. L., & Phillips, T. B. (2012). Key issues and new approaches for evaluating citizen-science learning outcomes. Frontiers in Ecology and the Environment, 10(6), 307-309.

Kieslinger, B., Schäfer, T., Heigl, F., Dörler, D., Richter, A., & Bonn, A. (2017). The Challenge of Evaluation: An Open Framework for Evaluating Citizen Science Activities.

Kieslinger, B., Schäfer, T., Heigl, F., Dörler, D., Richter, A., & Bonn, A. (2018). Evaluating Citizen Science: Towards an open framework. Book Chapter In: Citizen Science – Innovation in Open Science, Society and Policy. London: UCL Press.

Kullenberg, C., Kasperowski, D. (2016). What Is citizen science? – a scientometric meta-analysis. PloS One 11, 1–16.

National Research Council. (2009). Learning science in informal environments: People, places, and pursuits. Washington, DC: The National Academies Press.

OECD. (2014). Assessing the Impact of State Interventions in Research – Techniques, Issues and Solutions: Directorate for Science, Technology and Innovation. unpublished manuscript.

Phillips, T., Bonney, R., & Shirk, J. (2012). What is our impact? Toward a Unified Framework for Evaluating Outcomes of Citizen Science Participation. Citizen science: Public participation in environmental research, 82-95.

Phillips, T., Ferguson, M., Minarchek, M., Porticella, N., & Bonney, R. (2014). Evaluating learning outcomes from citizen science. Ithaca, New York: Cornell Lab of Ornithology.

Phillips, T., Porticella, N., Constas, M., & Bonney, R. (2018). A Framework for Articulating and Measuring Individual Learning Outcomes from Participation in Citizen Science. Citizen Science: Theory and Practice, 3(2).

Schäfer, T., & Kieslinger, B. (2016). Supporting emerging forms of citizen science: A plea for diversity, creativity and social innovation. Journal of Science Communication, 15(02), Y02.

Shirk, J., Ballard, H., Wilderman, C., Phillips, T., Wiggins, A., Jordan, R., . . . Krasny, M. (2012). Public participation in scientific research: a framework for deliberate design. Ecology and Society, 17(2).

UNEP (2002) Environmental Impact Assessment – Training Resource Manual, Division of Technology, Industry and Economics, Economics and Trade Branch, Second Edition.

Wehn, U. and Evers, J. (2015) The social innovation potential of ICT-enabled citizen observatories to increase eParticipation in local flood risk management, Technology in Society, August, pp.187-198, doi:10.1016/j.techsoc.2015.05.002.

Wehn, U., Gharesifard, L., & Anema, K., M., Alfonso, Mazzoleni, M. (2019). Initial validation and socio-economic impacts report, Ground Truth 2.0 project deliverable D1.11. Delft, the Netherlands, September.

Wehn, U., Pfeiffer, E., Gharesifard, M., Alfonso, L., & Anema, K. (2020). Updated validation and socio-economic impacts report, Ground Truth 2.0 project deliverable D1.12. Delft, the Netherlands, February.

Wehn, U., Pfeiffer, E., Gharesifard, M., Anema, K., & Remmers, M. (2017). Methodology for validation and impact assessment, Ground Truth 2.0 project deliverable D1.10. Delft, the Netherlands, January.

Wiggins, A., Bonney, R., LeBuhn, G., Parrish, J. K., & Weltzin, J. F. (2018). A Science Products Inventory for Citizen-Science Planning and Evaluation. BioScience, 68(6), 436-444. doi:10.1093/bioscience/biy028.

Woods, M., Hemment, D. & Bui, L. (2015) Community Level Indicators, Making Sense project deliverable D5.4, May.

Annex 1 - Template to review Impact Assessment methods

General information about the method	
Method name:	*What's the name of the impact assessment/capturing method?* *If the method does not have a specific name, please mention: not applicable or N/A*
Reference(s) to the method (incl. URL):	*Please provide a reference to the method, e.g. a website, paper or report that explains the method*
What is your relationship to this method?	*Please tick as many as applicable:* ● *Owner / creator* ● *Adapter / iterator* ● *User* ● *Interested in* ● *Other - please specify*
What are the required inputs for using the method?	*By required inputs, we mean the information that you need to have, to be able to use the method (e.g. a good understanding of the involved stakeholders in governance processes, project goals and objectives, etc.). If you are not the owner/creator or have never used the method, this might be challenging to answer. If you are not sure about the answer, please mention: I am not sure* -
What are the conditions for using this method?	*Some examples of conditions for using methods are Intellectual Property Right (IPR), creative commons licence, pricing*
Who is the intended user of the method?	*Some examples of intended users are citizens, researchers and decision makers*

Details about capturing impacts & value	
What is the method designed for?	*Please explain what the purpose of the methods is, i.e. what is the origin of change that the method is helping to capture the impacts of (e.g. intervention, Citizen Science, Nature-Based Solutions, etc.).*
From which perspective does this method capture	*Please tick as many as applicable:*

impacts/value?	• *citizens,* • *scientists* • *commercial data aggregators* • *decision makers* • *policy makers*
Which types of impact domains/categories does the method distinguish?	• *Society* • *Governance* • *Economy* • *Environment* • *Science* • *Others*
How does this method *define* impact & value?	*Please explain as detailed as possible how exactly this method defines impact & value (definitions of key terms, indicators, etc.).*
How does this method serve to *capture* impact & value?	*Please explain as detailed as possible the methodological steps of capturing and analysing data for defined indicators/dimensions.*
What are the assumptions of the method?	*Capturing impact using any method needs making assumptions. We are interested in knowing the assumptions of this method. If you are not the owner/creator or have never used the method, this might be challenging to answer. If you are not sure about the answer, please mention: I am not sure*

Experience with applying the method	
Has the method been used before to capture impacts/value? If yes, in which project or context?	*Please mention the name of the project, field of research or phenomena that this method has been applied to. If possible, please also provide links to websites, papers or other documents that mention the application of the method.*
What are the strengths of this method?	*In your view, what are the strengths of the method for capturing the impacts & value of Citizen Observatories or Citizen Science for governance?*

What are the weaknesses of this method?	*In your view, what are the weaknesses of the method for capturing the impacts & value of Citizen Observatories or Citizen Science for governance?*
Is there anything else you would like to share about this method?	

Annex 2 - Reviewed general Impact Assessment frameworks

Global Reporting Initiative

General information about the method	
Method name:	GRI Standards. GRI: Global Reporting Initiative
Reference(s) to the method (incl. url):	GRI Sustainability Reporting Standards (GRI Standards) help businesses, governments and other organizations understand and communicate the impact of business on critical sustainability issues. The GRI Standards enable all organizations to report publicly on their economic, environmental and social impacts – and show how they contribute towards sustainable development**.** See: https://www.globalreporting.org/information/about-gri/Pages/default.aspx See: https://www.globalreporting.org/information/sustainability-reporting/pages/gri-standards.aspx There are around 169 disclosures divided into 3 universal Standards, applicable to all organizations and 33 topic-specific Standards, organized into Economic, Environmental, and Social series. See excel: https://standards.sinzer.org/download?file=mapping-g4-to-the-gri-standards-complete%20kopie.xlsx (Tap: Disclosures Full Overview; Colum: J and M)
What is your relationship to this method?	*Please tick as many as applicable:* ● *Owner / creator* ● *Adapter / iterator* ● *User* ● *Interested in* ● *Other✓ - please specify:* Reviewer

What are the required inputs for using the method?	An organization that wants to prepare a **sustainability report** needs to meet the following requirements: 1. **Applying the Reporting Principles.** The reporting organization shall apply all Reporting Principles to define report **content** and **quality**. Related to **content**: o **Stakeholder Inclusiveness**: The reporting organization shall **identify** its **stakeholders**, and explain how it has responded to their reasonable expectations and interests. o **Sustainability Context**: The report shall present the reporting **organization's performance** in the wider context of sustainability. o **Materiality:** The report shall cover topics that reflect the reporting organization's significant economic, environmental, and social impacts; and substantively influence the assessments and decisions of stakeholders. o **Completeness:** The report shall include coverage of material topics and their Boundaries, sufficient to reflect significant economic, environmental, and social impacts, and to enable stakeholders to assess the reporting organization's performance in the reporting period. Related to **quality**: o **Accuracy**: The reported information shall be sufficiently **accurate** and **detailed** for stakeholders to assess the reporting organization's performance. o **Balance**. The reported information shall reflect **positive** and **negative** aspects of the reporting organization's performance to enable a reasoned assessment of overall performance. o **Clarity**: The reporting organization shall make **information available** in a manner that is understandable and accessible to stakeholders using that information. o **Comparability**: The reporting organization shall select, compile, and report information consistently. The reported information shall be presented in a manner that **enables stakeholders to analyze changes** in the organization's performance over time, and that could support analysis relative to other organizations.

	○ **Reliability**: The reporting organization shall gather, record, compile, analyze, and report information and processes used in the preparation of the report in a way that they can be subject to examination, and that establishes the quality and materiality of the information. ○ **Timeliness**: The reporting organization shall report on a regular schedule so that information is available in time for stakeholders to make informed decisions. See: CONSOLIDATED SET OF GRI SUSTAINABILITY REPORTING STANDARDS 2018 (Page 26; Table 1), (Page 20) 2. **Reporting general disclosures.** Organizational profile, Strategy, Ethics and integrity, Governance, Stakeholder engagement, and Reporting practice 3. **Identifying material topics and their Boundaries.** The reporting organization shall identify its **material topics** and the **Boundary** for each **material topic**. See: CONSOLIDATED SET OF GRI SUSTAINABILITY REPORTING STANDARDS 2018 (Page 40), (Page 20) Moreover, the organization shall comply with the **general requirements** for reporting the **management approach** ○ Explanation of the material topic and its boundary - Explain why the topic is material, the boundary for the material topic, and any limitations for the topic boundary ○ The management approach and its components - How the organization manages the topic, the purpose of the management approach, and a description of (Policies Commitments Goals and targets Responsibilities, Resources, Grievance mechanisms, Specific actions, such as processes, projects, programs and initiatives) ○ Evaluation of the management approach. How the organization evaluates the management approach See: CONSOLIDATED SET OF GRI SUSTAINABILITY REPORTING STANDARDS 2018 (Page 87)

	Finally, the organization shall: - Use the correct claim (statement of use) in any published materials with disclosures based on the GRI Standards - Ensure that reasons for omission are used correctly, if applicable - Notify GRI of the use of the Standards See: CONSOLIDATED SET OF GRI SUSTAINABILITY REPORTING STANDARDS 2018 (Page 26; Table 1)
What are the conditions for using this method?	The Sustainability Reporting Standards are a free public good. See: https://www.globalreporting.org/information/about-gri/Pages/default.aspx Pricing for the Standard Alignment Check See: https://www.globalreporting.org/information/FAQs/Pages/GRIs-Services.aspx Using the **standards** requires including a specific claim in all published materials, and notifying GRI of the use of the Standards. To claim that a sustainability report has been prepared in accordance with the GRI **Standards, the reporting organization shall meet all criteria for the respective option (Core or Comprehensive)** - ***Core.*** This option indicates that a report contains **the minimum information** needed to understand the nature of the organization, its material topics and related impacts, and how these are managed. - ***Comprehensive.*** This builds on the Core option by requiring **additional disclosures** on the organization's strategy, ethics and integrity, and governance. In addition, the organization is required to report more extensively on its impacts by reporting all the topic-specific disclosures for each material topic covered by the GRI Standards. **Criteria to claim** a report has been prepared in accordance with the GRI Standards: - Use the correct claim (statement of use) in any published materials with disclosures based on the GRI Standards

	○ Use GRI **101**: Foundation to follow the **basic process** for preparing a sustainability report ○ Use GRI **102**: General Disclosures to report **contextual information** about the organization ○ Use GRI **103**: Management Approach to report **the management approach** and the **topic Boundary** for all material topics ○ Use the topic-specific GRI Standards (series 200, 300, 400) to report on **material topics** - Ensure that reasons for omission are used correctly, if applicable - Notify GRI of the use of the Standards See: GRI 101: Foundation (Section 3) See: GRI Digital Reporting Tool. User License Agreement
Who is the intended user of the method?	The method considers different stakeholder interest, such as business, governments, civil society, and citizens. See: https://www.sustainability-reports.com/organizations/ It is designed for capturing the impact of **organisations** of **all sizes and types** operating in any sector. However, they were developed primarily with the needs of **larger businesses** in mind. See: https://nefconsulting.com/our-services/evaluation-impact-assessment/prove-and-improve-toolkits/gri-guidelines/#who

Details about capturing impacts & value	
What is the method designed for?	GRI standards are designed to help organizations **communicate** about their **impacts on the economy, the environment, and society** – and thus how they contribute towards the goal of sustainable development. See: Introduction to the GRI Standards

	An organization preparing a report in accordance with the GRI Standards is expected to report not only on **impacts it causes**, but also on **impacts it contributes to**, and impacts that are directly **linked to its activities, products or services** through a business relationship. See document: GRI 101: Foundation
From which perspective does this method capture impacts/value?	*Please tick as many as applicable:* ● Citizens✓ - civil society ● Scientists✓ - academics ● commercial data aggregators✓ - business - accounting ● decision makers✓ - governments - practitioners ● policy makers✓ - investors ● other:… ✓ - labour See: https://www.globalreporting.org/information/sustainability-reporting/pages/gri-standards.aspx
Which types of impact domains/categories does the method distinguish?	● Economy ✓ - GRI 201: Economic Performance 2016 - GRI 202: Market Presence 2016 - GRI 203: Indirect Economic Impacts 2016 - GRI 204: Procurement Practices 2016 - GRI 205: Anti-corruption 2016 - GRI 206: Anti-competitive Behavior 2016

	• Environment ✓ - GRI 301: Materials 2016 - GRI 302: Energy 2016 - GRI 303: Water and Effluents 2018 - GRI 304: Biodiversity 2016 - GRI 305: Emissions 2016 - GRI 306: Effluents and Waste 2016 - GRI 307: Environmental Compliance 2016 - GRI 308: Supplier Environmental Assessment 2016 • Society✓ - GRI 401: Employment 2016 - GRI 402: Labor/Management Relations 2016 - GRI 403: Occupational Health and Safety 2018 - GRI 404: Training and Education 2016 - GRI 405: Diversity and Equal Opportunity 2016 - GRI 406: Non-discrimination 2016 - GRI 407: Freedom of Association and Collective Bargaining 2016 - GRI 408: Child Labor 2016 - GRI 409: Forced or Compulsory Labor 2016 - GRI 410: Security Practices 2016 - GRI 411: Rights of Indigenous Peoples 2016 - GRI 412: Human Rights Assessment 2016 - GRI 413: Local Communities 2016 - GRI 414: Supplier Social Assessment 2016 - GRI 415: Public Policy 2016 - GRI 416: Customer Health and Safety 2016 - GRI 417: Marketing and Labelling 2016 - GRI 418: Customer Privacy 2016 - GRI 419: Socioeconomic Compliance 2016 • Governance✓

	- Organizational governance (GRI 102) ● Science ● Others: ✓ - Organizational ethics and integrity (GRI 102) See: GRI Topic-specific Standards (Economic, Environmental, Social)
How does this method *define* impact & value?	**Impact**: 'impact' refers to the **effect** an organization has on the economy, the environment, and/or society, which in turn can indicate its contribution (positive or negative) to sustainable development. - In the GRI Standards, the term 'impact' can refer to **positive, negative, actual, potential, direct, indirect, short-term, long-term, intended, or unintended** impacts. - Impacts on the economy, environment, and/or society can also be related to **consequences for the organization** itself. For example, an impact on the economy, environment, and/or society can lead to consequences for the organization's business model, reputation, or ability to achieve its objectives. This method has **Reporting Principles** for defining report **content** and **quality**. The report **content** helps organizations decide which content to include in the report and the report **quality** guide choices on ensuring the quality of information. - Content: Stakeholder inclusiveness, sustainability context, materiality, completeness - Quality: Accuracy, balance, clarity, comparability, reliability, timeliness. The reporting topics shall be prioritized. This depends on the relation between 'the influence on stakeholder assessment & decision' and 'the significance of the reporting organization's economic, environmental & social impact'. **Topic Boundary**: where the impacts occur for a material topic, and the organization's involvement with those impacts **Material topic:** topic that reflects a reporting organization's significant economic, environmental and social impacts; or that substantively influences the assessments and decisions of stakeholders See: GRI Standard Glossary! To know more about the terms and definitions applied in the context

How does this method serve to *capture* impact & value?	How to use the GRI Standards for sustainability reporting Steps to report using **universal** standards and **topic-specific** standards. - GRI 101 Foundation: Starting point for using the GRI standards. *1.* Choose an option for reporting (core or comprehensive) *2.* Apply the reporting principles throughout the reporting process. *3.* Identify the material topics (economic, environmental, social) - GRI 102 General Disclosure: To report contextual information **about the organization**. Organizational profile, strategy, ethics and integrity, governance, stakeholder engagement, reporting practice. - GRI 103 Management Approach: To report management approach for each material topic Explanation of the **material topic and its boundary, management approach and its components, and evaluation of the management approach.** - Each Topic-Standard has: Reporting requirements (required information to report), reporting recommendations (actions that are encouraged, but not required) and guidance (background information, explanation, examples). ○ GRI 200 Economic ○ GRI 300 Environmental ○ GRI 400 Social See: Introduction of the GRI Standards (page 19)
What are the assumptions of the method?	Not clear

Experience with applying the method	
Has the method been used before to capture impacts/value? If yes, in which project or context?	There are significant amount of reports based on GRI standards. Find below two noted examples: Bloomberg Impact report – Bloomberg is a privately held financial, software, data, and media company. Reporting framework on different impact issues and levels.

	SGS Group Management – SGS is a verification, inspection, testing and certification company. (Page 134-139 GRI report on different disclosures) See: https://www.globalreporting.org/reportregistration/verifiedreports
What are the strengths of this method?	- **It helps mobilize many private sector companie**s to align with **sustainability goals** to fill the funding gap. - When reporting to multiple funders, the existence of **standardized metrics** (e.g. GRI) may help reduce the work of reporting. - **Well-defined metrics** accompanied with definitions, sample answers, usage guidelines, and so on, ensure that the **funder and funded organizations are aligned**. See: https://www.sopact.com/perspectives/standardized-social-impact-metrics - A more **flexible** and **future-proof structure**: up-to-date and relevant - Greater suitability for referencing in policy initiatives: to enable further integration into government and market legislation around the world - A **global common language** for non-financial information: one universal framework and set of **disclosures** to meet all sustainability reporting needs - Standards that are **credible** and **robust**: developed with true multi- stakeholder contributions and rooted in the public interest See: Introduction to the GRI Standards - **Aligning language** and giving organizations **clearer distinctions** between reporting requirements (“shall”), recommendations (“should”), and guidance. - Revising many disclosure ‘requirements’ to ‘recommendations,’ providing organizations with **flexibility to report** available and material information. - More detail on describing the **management approach to material topics**, including information on policies, commitments, goals and targets, responsibilities, resources, grievance mechanisms and specific actions that the organization uses. See: Global Reporting Initiative (GRI) standards

	Internal benefits: - Increased understanding of risks and opportunities - Emphasizing the link between financial and non-financial performance - Influencing long term management strategy and policy, and business plans - Streamlining processes, reducing costs and improving efficiency - Benchmarking and assessing sustainability performance with respect to laws, norms, codes, performance standards, and voluntary initiatives - Avoiding being implicated in publicized environmental, social and governance failures - Comparing performance internally, and between organizations and sectors External benefits: - Mitigating – or reversing – negative environmental, social and governance impacts - Improving reputation and brand loyalty - Enabling external stakeholders to understand the organization's true value, and tangible and intangible assets - Demonstrating how the organization influences, and is influenced by, expectations about sustainable development See: https://www.globalreporting.org/information/sustainability-reporting/pages/reporting-benefits.aspx - Organisations can use GRI reporting **to help measure and benchmark performance**, both against their own targets and externally. Management can use the GRI indicators to encourage employees to understand and **contribute** to progressively **better performance**. - The Guidelines are flexible and can be used in different **sectors** and **geographical contexts.** See: https://nefconsulting.com/our-services/evaluation-impact-assessment/prove-and-improve-toolkits/gri-guidelines/ (Reference G3)
What are the weaknesses of this method?	- Respondents indicated that while they understand the reasons for the **modular structure** of

	the GRI Standards, this could adversely impact **usability** of the Standards. A main concern was that users would have to access multiple PDF documents, rather than being able to find and search all content in one or two documents - Respondents were very positive about the **clearer distinction** between requirements, recommendations, and guidance in the draft Standards. However, respondents felt that the distinction between 'requirements' and other sections (i.e. recommendations and guidance) should be **more evident** to help users easily identify mandatory text. - A number of respondents raised concerns about using 'shall' and 'should' to signify requirements and recommendations throughout the draft Standards. Comments suggested that these verbs can be interpreted in a very similar way for users, which would be confusing. See document: GRI Standards Basis for Conclusions - **Voluntary** nature of reporting. Use of GRI protocol is voluntary so many companies would not do that. - **Demanding**. Better ways to report need to be developed. - Multi-stakeholder governance system. Even broad, there is an **imbalanced representation** of social groups. See: Barriers to Strengthening the Global Reporting Initiative Framework: Exploring the perceptions of consultants, practitioners, and researchers (Figure2) - Their history of use in the third sector (voluntary sector) is limited and some of the language and approaches are more familiar and appropriate for multinational corporations. - They provide guidance, but not accreditation, a mark or external evaluation unless combined with other tools, such as an assurance standard. - Their main focus is 'sustainability', e.g. reporting external impact but not necessarily focusing on positive outcomes or impacts. See: https://nefconsulting.com/our-services/evaluation-impact-assessment/prove-and-improve-toolkits/gri-guidelines/ (Reference to G3)

Is there anything else you would like to share about this method?	How the relevant SDGs are addressed within the GRI disclosures, see: https://www.globalreporting.org/standards/resource-download-center/sdg-compass-annex-linking-the-sdgs-and-gri-standards/

Magenta Book

General information about the method	
Method name:	The Magenta Book
Reference(s) to the method (incl. url):	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/220542/magenta_book_combined.pdf
What is your relationship to this method?	*Please tick as many as applicable:* ● *Owner / creator* ● *Adapter / iterator* ● *User* ● *Interested in* ✓ ● *Other - please specify:*
What are the required inputs for using the method?	A good understanding of the involved stakeholders in governance processes, project goals and objectives
What are the conditions for using this method?	You may re-use this information (not including logos) free of charge in any format or medium, under the terms of the Open Government Licence. To view this licence, visit http://www.nationalarchives.gov.uk/doc/opengovernment-licence/
Who is the intended user of the method?	Part A: policy makers at all levels of government, both central and local. Part B: analysts and interested policy makers

Details about capturing impacts & value	
What is the method designed for?	The primary focus of the Magenta Book is on policy evaluation*, which examines how a policy or other intervention was designed and carried out and with what results. * The Magenta Book generally uses the term 'policy evaluation' to refer to evaluations covering projects, policies and programmes
From which perspective does this method capture impacts/value?	*Please tick as many as applicable:* ● *citizens,* ● *scientists* ● *commercial data aggregators* ● *decision makers* ✓ ● *policy makers* ✓ ● *other:…* ***"Analysts"***
Which types of impact domains/categories does the method distinguish?	● *Society* ● *Governance* ✓ ● *Economy* ● *Environment* ● *Science* ● *Others*
How does this method *define* impact & value?	"Impact can in principle be defined in terms of any of the outcomes affected by a policy (e.g. the number of job interviews or patients in treatment), but is most often focused on the outcomes which most closely match with the policy's ultimate objectives (e.g. employment rates or health status)." …"A key concept in impact evaluation is the counterfactual – what would have occurred had the policy not taken place. By definition it cannot be observed directly, because the policy did take place. Impact evaluation seeks to obtain a good estimate of the counterfactual, usually by reference to situations which were not exposed to the policy"

	Value is referred to in terms of “value for money”
How does this method serve to *capture* impact & value?	Evaluation is an integral part of a broad policy cycle that the Green Book formalises in the acronym ROAMEF. ROAMEF stands for Rationale, Objectives, Appraisal, Monitoring, Evaluation and Feedback There are three main types of evaluation: • Process evaluations assess whether a policy is being implemented as intended and what, in practice, is felt to be working more or less well, and why. • Impact evaluations attempt to provide an objective test of what changes have occurred, and the extent to which these can be attributed to the policy. • Economic evaluations, in simple terms, compare the benefits of the policy with its costs The main steps in the evaluation process are 1. Define the policy objectives and intended outcomes 2. Consider the implications of policy design for evaluation feasibility 3. Define the audience for evaluation 4. Identify the evaluation objectives and research questions a. How broad is the scope of evaluation? b. What do policy makers need to know about what difference the programme made? 5. Select the evaluation approach – here, we are interested in impact 6. Identify the data requirements a. Time points for collection b. Data required c. What is collected already/ what else needs collecting? d. Who is responsible for collecting data? 7. Identifying the necessary resources and governance arrangements 8. Conducting the evaluation 9. Using and disseminating the evaluation findings

What are the assumptions of the method?	Part B assumes a basic knowledge of statistics, for example hypothesis testing and the t-test

Experience with applying the method	
Has the method been used before to capture impacts/value? If yes, in which project or context?	HM Treasury's Green and Magenta Books together provide detailed guidelines, for policy makers and analysts, on how policies and projects should be assessed and reviewed.
What are the strengths of this method?	The method is aimed at policy makers, making it particularly relevant for COs/CS for governance Emphasizes the importance of: • researcher independence and objectivity for evaluation • inclusion of recipients, delivery bodies or stakeholders – through a steering group, • for example – to enhance the potential learning from an evaluation • transparency • robustness in research plans
What are the weaknesses of this method?	It may be argued, even for a relatively important intervention, that it is not possible to afford a full evaluation, in line with the recommendations in the Magenta Book
Is there anything else you would like to share about this method?	

IRIS+

General information about the method	
Method name:	IRIS +
Reference(s) to the method (incl. url)	IRIS+ is the generally accepted system for **measuring, managing, and optimizing impact**. IRIS+ makes it easier for **investors** to translate their impact intentions into real impact results. It allows investors to focus their capital allocation decisions and drive greater impact on the world's most pressing social and environmental issues. *See: https://iris.thegiin.org/about/* Through IRIS + system, **investors and companies** will have a common understanding of how to effectively **measure and manage their impact and clarity for how to improve that impact** over time. IRIS+ combines **impact** investing's most widely used impact performance metrics with research, evidence, and practical implementation guidance into a single curated system. IRIS+ metrics are designed to **measure the social, environmental and financial performance of an investment**. The IRIS+ catalogue contains a total of **594** indicators. *See:* https://iris.thegiin.org/history/ and *See report:* The DCED Standard and GIIN's IRIS+ and Navigating Impact Project
What is your relationship to this method?	*Please tick as many as applicable:* ● *Owner / creator* ● *Adapter / iterator*

	• *User* • *Interested in* • *Other ✓ - please specify :* Reviewer
What are the required inputs for using the method?	The required inputs are quite diverse and depend on the category of impact that the user is interested in. For using some of the indicators in the IRIS Catalogue of Metrics, baseline data may be required in order to be able to use most of the indicators.
What are the conditions for using this method?	The GIIN offers IRIS+ as a **free** and **public good** to advance impact investing around the world. See the link (*https://iris.thegiin.org/terms-of-use/*) for the Terms of Use of the www.thegiin.org website, which hosts the IRIS+ method.
Who is the intended user of the method?	**Decision makers, impact investors, enterprises, intermediaries or service providers working with impact investors**. *See:* IRIS+ for Decision Making

Details about capturing impacts & value	
What is the method designed for?	The Navigating Impact project was created by the Global Impact Investing Network (GIIN) to **help investors select impact strategies and adopt metrics that indicate performance toward their goals**. Created in consultation with **industry experts, impact investors**, and **standards setters**. *See:* Core Metrics sets.

	Impact measurement and management are integral to making effective impact investments. It includes identifying and considering the positive and negative effects one's business actions have on people and the planet, and then figuring out ways to mitigate the negative and maximize the positive in alignment with one's goals. Impact measurement & management is iterative by nature. **Consider these four distinct actions to get started:** 1. **Set goals & expectations:** Goals should consider the effects an investment has on people and/or the planet and balance investor expectations for risk, return, liquidity and impact. 2. **Define strategies:** There are many pathways to achieving impact goals and meeting expectations. Consider what pathways make the most sense for your portfolio, investment expertise, or client demand. 3. **Select metrics & set targets:** Use relevant output, outcome, and proxy indicators to set targets (as appropriate), track performance, and manage toward success. Impact metrics should ultimately deliver investment decision information, help you learn and pivot when necessary, and strengthen the performance of your portfolio and investment strategy. 4. **Measure, track, use the data, and report:** Impact measurement & management is more than counting metrics. It means considering information about risks, returns, and impact to learn, adjust, and improve investment decision-making. *See: https://thegiin.org/imm/#imm-tools-resources*
From which *perspective* does this method capture impacts/value?	*Please tick as many as applicable:* ● *citizens,* ● *scientists* ✓ ● *commercial data aggregators* ✓ ● *decision makers* ✓ ● *policy makers* ✓ ● *Others*

	Investors, standards setters, data providers, evaluators, and industry networks *See info: https://iris.thegiin.org/standards-development-process-and-principles/*
Which types of *impact* domains/categories does the method distinguish?	• *Society*✓ - Diversity & inclusion (Gender). - Education (Access to Quality Education). - Employment. - Health (Access to Quality Health Care, Nutrition). - Real Estate (Affordable Quality Housing, Green buildings). • *Governance* • *Economy*✓ - Financial Services (Financial Inclusion) • *Environment*✓ - Agriculture (Food Security, Smallholder Agriculture, Sustainable Agriculture). - Air (Clean Air). - Biodiversity and Ecosystems (Biodiversity & Ecosystem Conservation). - Climate (Climate Mitigation, Climate Resilience and Adaptation). - Energy (Clean Energy, Energy Access, Energy Efficiency). - Land (Natural Resources Conservation, Sustainable Land Management, Sustainable Forestry) - Oceans & coastal zones (Marine Resources Conservation & Management) - Pollution (Pollution Prevention). - Waste (Waste Management). - Water (Sustainable Water Resources Management Water, Sanitation, and Hygiene (WASH). • *Science* • *Others*

	IRIS+ identifies 16 impact categories. Some of these categories belong to one impact themes and others are cross-cutting or belong to more than one theme. The categorization is just an example of how these impact categories may be organized under the themes society, economy and environment. *See document:* IRIS+ Thematic Taxonomy. Impact categories for possible **future development** - arts & culture, capacity building, community development, information, communication & connectivity, infrastructure, transportation.
How does this method *define* impact & value?	See this link for the glossary of definition: https://iris.thegiin.org/glossary/
How does this method serve to *capture* impact & value?	Using IRIS+ Core Metrics Sets and the IRIS Catalogue of Metrics it is possible to describe the core concepts and **structure for measuring** and understanding impact according to the five dimensions of impact. IRIS+ Core Metrics Sets are short **lists of key impact performance indicators** that impact investors can use **to assess the effects of their investments.** These are based on **Impact Management Project (IMP),** a forum for building global consensus on **how to measure** and **manage impact**. **5 Impact dimensions and 16 categories of data to assess the impact performance.** 1. **What** is the goal? It helps enterprises and investors to **identify the outcomes to which they are contributing** and to understand the importance of those effects for stakeholders. There are 4 data categories enterprises and investors can use to collect, asses, and report outcome: ○ **Outcome level in period.** The level of outcome experienced by the stakeholder when engaging with the enterprise. Types of outcome indicators: number, percentage, ratio, categorical and the range of outcomes (positive, negative, intended, unintended) ○ **Importance of outcome to stakeholders.** Stakeholder's view of whether the outcome they experience is important.

	○ **Outcome threshold.** The level of outcome that the stakeholder considers to be positive/good enough (Standard-based threshold or Result-based threshold) ○ **SDG/SDG target.** The sustainable development goal that the outcome relates to. 2. **Who** is affected? It describes who experiences the effect and how underserved are they in relation to the outcome. ○ **Stakeholder**: The type of stakeholder experiencing the outcome ○ **Geographical Boundary**: The geographical location where the stakeholder experiences the social and/or environmental outcome. ○ **Baseline**: The level of outcome experienced by the stakeholder prior to engaging with the enterprise ○ **Stakeholder Characteristics**: Socio-demographics and behavioural characteristics of the stakeholder to enable segmentation during the intervention. 3. **How much** change is happening? It covers the data needed to understand the significance of the outcome in terms of scale, depth, and duration ○ **Scale**: Number of stakeholders are experiencing the outcome. (Small/large scale) ○ **Depth**: This indicator measures the degree of change experienced by the target stakeholders, that is, the change in outcome identified in the WHAT dimension for the target stakeholder group identified in the WHO dimension (Low/high degree) ○ **Duration**: The time period for which the stakeholder experiences the outcome (short/long term) 4. What is the **contribution**? It covers the data needed to assess an enterprise's contribution to the social and environmental outcomes that people and planet experience relative to what the market or social system would have achieved anyway. It is a comparison of the

	depth and duration data (under the HOW MUCH dimension) against local or peer benchmarks. It is divided in 2 categories: ○ **Depth**: The estimated degree of change that would occur anyway for the stakeholder ○ **Duration**: The estimated time period for which the stakeholder would have experiences the outcome anyway Methods to calculate depth and duration. See: https://impactmanagementproject.com/impact-management/what-is-impact/contribution/ With very few exceptions, IRIS metrics do not align with contribution. For that reason, IRIS+ Core Metrics Sets do not yet identify specific metrics for this dimension, instead pointing to guidance by the Impact Management Project. 5. What is the impact **risk**? Which risk factors are significant and how likely is it that the outcome is different from the expectation? ○ **Risk Type:** The probability that the evidence on which the strategy is based in not good evidence that the expected impact will occur ○ **Risk Level**: The probability that external factors disrupt our ability to deliver the expected impact. The type of impact risk, typically described using one of 10 risk factors: evidence risk, external risk, execution risk, stakeholder participation risk, drop-off risk, unexpected impact risk, efficiency risk, contribution risk, alignment risk, and endurance risk. Since IRIS metrics do not cover all risk factors under the risk dimension, no IRIS metrics have been aligned to the RISK dimension. Such alignment and risk-specific metric development is planned for future collaboration among the GIIN, IMP, and other stakeholders in the field.

What are the assumptions of the method?	Not specified

Experience with applying the method	
Has the method been used before to capture impacts/value? If yes, in which project or context?	Applying IRIS to Active Investment Portfolio. They used to identify new grants and investments. They used impact measuring and reporting to: illustrate the social, environmental, and financial success of the foundation; nurture their investments; evaluate future investments; and provide needed performance data to share with a growing community of impact investors. They combined the hard data provided by IRIS with the qualitative impact indicators from KL Felicitas Foundation standards. *See:* KL Felicitas Foundation Collecting Impact Data Using Mobile Technology. A pilot project measuring client poverty levels. Impact investors and mission-driven organizations serving the poor can use data indicating the poverty levels of their clients to measure and manage their social impact. *See:* Collecting Impact Data Using Mobile Technology
What are the strengths of this method?	It is **standardized, internationally recognized** and **not as expensive** as other methods involving customized metrics with control groups. Standardized metrics such as the IRIS system, have the advantage of their lower cost and their more widespread adoption in the field. It ensures **comparable data** and credible **aggregation** and analysis across the growing impact investing industry, it will also help investors and mission-driven businesses better **track, manage, and communicate** their own impact. *See:* The Best of Both Worlds? Impact Investors and Their Role in the Financial versus Social Performance Debate

	See: https://ssir.org/articles/entry/why_iris These standards are very important for creating a **common impact language**. If an organization is asked to report to multiple funders, the existence of **standardized metrics** may help reduce the work of reporting. Well-defined metrics accompanied with **definitions, sample answers, usage guidelines**, and so on, ensure that the funder and funded organizations are **aligned** in the ask of each metric. This also help in **aggregating** the collective impact at the investment or funder level. *See:* https://www.sopact.com/perspectives/standardized-social-impact-metrics **Usability**: They are **user-friendly** through their offering of online tools, public availing of reports and creating tools that store data such that updates are less time intensive **Inclusiveness**: Inclusiveness refers to **involving multiple stakeholders**, such as companies, investors, consulting firms and third parties and **drawing upon other methodologies**. **Value demonstrating and enhancing**: value is by giving feedback and best practices, rather than solely assigning a score or rank. *See:* A critical evaluation of social impact assessment methodologies and a call to measure economic and social impact holistically through the External Rate of Return platform
What are the weaknesses of this method?	The IRIS+ taxonomy is **agnostic**: it does not define whether certain categories or themes contribute more or less to positive or negative effects. *See:* IRIS+ Thematic Taxonomy IRIS provide standardized metrics for assessing some common output criteria. But this focus more on an enterprise's **operations** than on its products. With rare exceptions—most notably, the field of

	microfinance—there have been **few efforts to evaluate the actual outcomes** of market based social enterprises. *See:* When Can Impact Investing Create Real Impact? Standardized metrics such as the IRIS system, is **less precise**. Some investors have preferred **project-specific** approaches based on fewer indicators and with a more rigorous assessment of counterfactuals. *See:* The Best of Both Worlds? Impact Investors and Their Role in the Financial versus Social Performance Debate They are outputs which communicate implementation of a product, **not whether** that product is having a **positive effect on the lives of the target beneficiaries.** *See:* https://www.sopact.com/perspectives/iris-indicators Standardized social impact metrics are overwhelmingly oriented around outputs and activities rather than **measuring for results (outcomes) of intervention**. This poses a few problems, namely, that it is not measuring anywhere close to the impact resulting from intervention. Some **standard metrics** may not mission aligned for your organization and so may have to create **custom metrics.** An effective use of IRIS indicators must still include **assessments using the outcome-oriented approach**. *See:* https://www.sopact.com/perspectives/standardized-social-impact-metrics One of the challenges with implementation is their **limited context-specific** relevancy.

	To find the right metrics for your organization, the tools you use need to **speak your language** and **understand** your **context**. Across cultures we use different terms to describe similar concepts and if we don't find what we're looking for in a metrics catalogue we may assume it does not exist. *See:* https://www.sopact.com/perspectives/search-impact-indicators
Is there anything else you would like to share about this method?	Link to other taxonomies such as SDGs and GRI IRIS+ translates the **SDGs into aligned IRIS metrics** that investors can use throughout the investment management process. Impact investors and other impact investing stakeholders that rely on the SDGs to set and report their impact goals can use IRIS+ in two ways: **IRIS+ Core Metrics Sets:** Backed by evidence and based on best practice, IRIS+ Core Metrics Sets may be used to assess the effects of any investment or enterprise across the five dimensions of impact. The IRIS+ Core Metrics Sets are aligned to the SDG Goals, enable comparison of data, and help illuminate material understanding of impact performance. **IRIS Catalog of Metrics:** Home to all IRIS metrics, the Catalog contains the generally accepted impact performance metrics for impact investors. The IRIS Catalog of Metrics is aligned with SDG targets; every SDG target identified as investable has a related and comprehensive set of applicable IRIS metrics. This feature is best used by investors that want to adopt a subset of SDG target–aligned IRIS metrics to track progress toward self-articulated impact goals. Therefore, investors that describe their impact goals using SDGs at the Goal level can use IRIS+ to identify relevant Core Metrics Sets they can adopt to track and manage impact performance toward those goals. Similarly, impact investors that do not use the SDGs to frame their portfolios can nevertheless identify relevant SDGs mapping to their adopted Core Metrics Set(s). *See:* IRIS+ and the SDGs The **GRI and IRIS linkage** guide reinforces the compatibility of the two frameworks, and ensures

	consistency for organizations using both methods for reporting. The guide can be used to increase the quality of their reporting and decrease the burden of reporting similar information in multiple different frameworks. Showing the linkages between both frameworks, the value of impact measurement is increased. A notable difference between the GRI Guidelines and the IRIS catalogue is that GRI Guidelines set of principles which guide choices on what to report (i.e., on which topics) and on ensuring the quality of information in the report. The IRIS catalogue, on the other hand, focuses on a set of metrics and does not prescribe principles to be followed when reporting on the metrics. *See:* Linking GRI and IRIS

Results chain framework

General information about the method	
Method name:	Results Chain Framework
Reference(s) to the method (incl. url):	General: http://www.liaise-kit.eu/ia-method/result-chain-analysis Conservation specific: https://www.fosonline.org/wordpress/wp-content/uploads/2010/09/FOS_Results_Chain_Guide_2007-05.pdf
What is your relationship to this method?	*Please tick as many as applicable:* ● *Owner / creator* ● *Adapter / iterator* ● *User* ● *Interested in* ✓ ● *Other - please specify:*
What are the required inputs for using the method?	An initial results chain is based on a conceptual model, therefore a good overview of the conceptual model is required
What are the conditions for using this method?	This work is licensed under the Creative Commons Attribution-NoncommercialShare Alike 3.0 License. To view a copy of this license, visit http://creativecommons.org/licenses/by-nc-sa/3.0/
Who is the intended user of the method?	The analysis can be carried out by a single person or an assessment team using practical/ implicit knowledge

Details about capturing impacts & value	
What is the method designed for?	"Whether explicitly or implicitly, any IA [impact assessment] will need to draw on an analysis of causal chains"
From which perspective does this method capture impacts/value?	*Please tick as many as applicable:* ● *citizens* ✓ ● *scientists* ✓ ● *commercial data aggregators* ✓ ● *decision makers* ✓ ● *policy makers* ✓ ● *other:…*
Which types of impact domains/categories does the method distinguish?	● *Society* ✓ ● *Governance* ● *Economy* ✓ ● *Environment* ✓ ● Science ● *Others*
How does this method *define* impact & value?	"In principle, impacts represent long-term effects of policies"
How does this method serve to *capture* impact & value?	"A results-chain illustrates the causal sequence from cause to effect. Results-chains are logic diagrams showing the intervention and assumptions that link: • inputs (e.g. financial resources) • activities outputs (e.g. constructing roads) • outputs (immediate effects, e.g. roads constructed) • outcomes (behavioural changes of beneficiaries, e.g. increased use of motor cars and trucks) • and impacts (e.g. time savings for passengers, increased emissions) to which the intervention contributes"

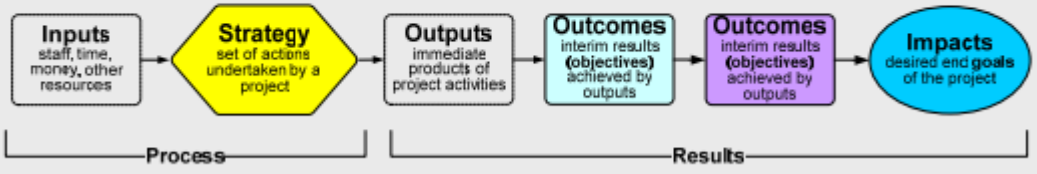
	"More specifically, for conservation projects, a results chain represents a team's assumptions about how project or program strategies will contribute to reducing important threats, leading to the conservation of priority targets. In essence, results chains are diagrams that map out a series of causal statements that link short-, medium-, and long-term results in an "if…then" fashion" **Box 1. An Overview of Terms Used to Describe Results** There is a great deal of confusion over the different terms used to describe the results of a project. What one person calls an "outcome," another calls a "result," and yet a third person calls an "impact." The following figure shows the terms as they are most commonly used by evaluation experts in different fields such as development and public health.  *Note: Results chains do not generally show inputs and outputs but rather focus on performance-oriented results* How to Develop and Use Results Chains: Step 1. Construct an Initial Results Chain Based on Your Conceptual Model Step 2. Complete the Links in the Results Chain Step 3. Verify that Your Results Chain Meets Criteria of a Good Results Chain Step 4. Develop Key Results Into Good Objectives Step 5. Establish Indicators to Monitor the Effectiveness of Your Strategy Step 6. Document Your Work

	Figure 11. Results Chain for a Strategy to Reduce Agricultural Expansion in Grasslands  *Adapted from the WWF Chihuahuan Desert Strategic Plan*
What are the assumptions of the method?	A results chain represents a team's assumptions Teams rarely formally state their assumptions about exactly how their strategies will achieve their desired outcomes and impacts. It is likely that they have many implicit assumptions about how their strategies will contribute to achieving their goals – these series of assumptions represent their "theory of change." At the same time, it is not uncommon for members from the same team to hold different assumptions that they have not communicated with one another. Because the assumptions are not explicit, the project team cannot come to an agreement on their theory of change or test it and learn over time whether it is valid

Experience with applying the method	
Has the method been used before to capture impacts/value? If yes, in which project or context?	Conservation - Using Results Chains to Improve Strategy Effectiveness - FOS How-To Guide May 2007
What are the strengths of this method?	• helps to make explicit assumptions about a policy's effects • helps to link an intervention to intended and unintended results • visualisation of the results-chain supports the involvement of the IA team/stakeholders/experts

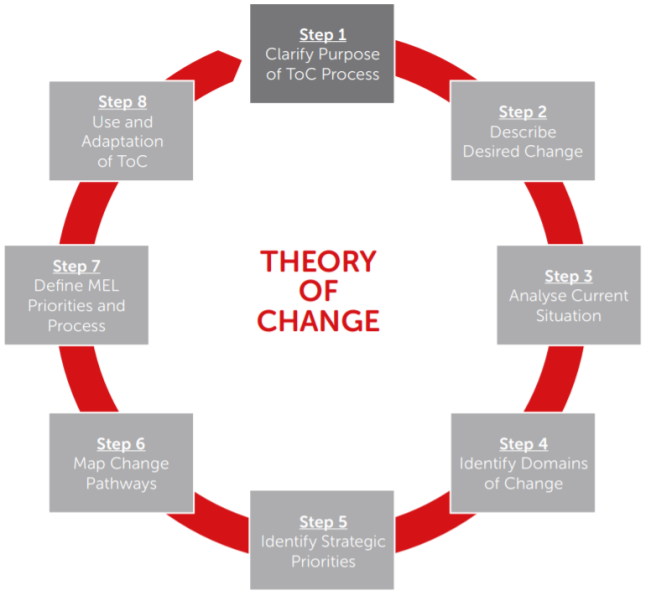
What are the weaknesses of this method?	• Does not show non-linear dynamics and visualizing comprehensive policy effects • Does not indicate the scope or quality of impacts
Is there anything else you would like to share about this method?	

Theory of Change

General information about the method	
Method name:	Theory of Change (ToC)
Reference(s) to the method (incl. url):	https://www.theoryofchange.org/ https://knowledge.hivos.org/sites/default/files/publications/hivos_toc_guidelines_final_nov_2015.pdf
What is your relationship to this method?	*Please tick as many as applicable:* ● *Owner / creator* ● *Adapter / iterator* ● *User* ● *Interested in* ✓ ● *Other - please specify:*
What are the required inputs for using the method?	"The people, time, materials and resources that need to be invested to achieve the goals."
What are the conditions for using this method?	HIVOS ToC Guidelines is published under a Creative Commons Attribution-Non Commercial-Share alike 3.0 License and may be copied freely for research and educational purposes and cited with due acknowledgement. See: https://knowledge.hivos.org/sites/default/files/publications/hivos_toc_guidelines_final_nov_2015.pdf https://www.theoryofchange.org/terms-of-use/
Who is the intended user of the method?	It is used in companies, non-profit and government sectors to promote social change. Researchers, decision makers.

Details about capturing impacts & value	
What is the method designed for?	Programme or Project Design, Review and/or quality audit of an existing initiative, Strategic learning design and knowledge generation, evaluation, multi-actor collaboration and collective impact monitoring, scaling up and scaling out. See: https://knowledge.hivos.org/sites/default/files/publications/hivos_toc_guidelines_final_nov_2015.pdf Page 18
From which perspective does this method capture impacts/value?	*Please tick as many as applicable:* ● *citizens* ● *scientists* ● *commercial data aggregators* ● *decision makers* ✓ ● *policy makers* ● *other:…Project managers*
Which types of impact domains/categories does the method distinguish?	● *Society* ✓ ● *Governance* ✓ ● *Economy* ✓ ● *Environment* ✓ ● Science ● *Others* See: https://knowledge.hivos.org/sites/default/files/publications/hivos_toc_guidelines_final_nov_2015.pdf Page 65: sociocultural, political, economic, environment.

How does this method *define* impact & value?	Impact: Desired change. See: https://knowledge.hivos.org/sites/default/files/publications/hivos_toc_guidelines_final_nov_2015.pdf (Page 112) Long-term changes are the results that derive from an accumulation of outcomes. These can be similar to strategic objectives See: https://english.rvo.nl/sites/default/files/2018/11/FBK_theory_of_change_guidelines_0.pdf The organizational, community, social and systemic changes that result from the program (intended or unintended) See: https://static1.squarespace.com/static/57a0dd1dbebafbfbfe80f9a7/t/5818db1e3e00be2eafd93a52/1478023968926/12b+-+Theory+of+Change+-+SP.pdf

How does this method serve to *capture* impact & value?	 See: https://knowledge.hivos.org/sites/default/files/publications/hivos_toc_guidelines_final_nov_2015.pdf Steps - Page 34-71

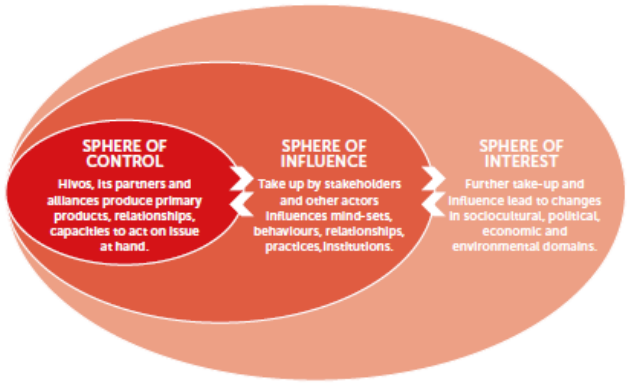
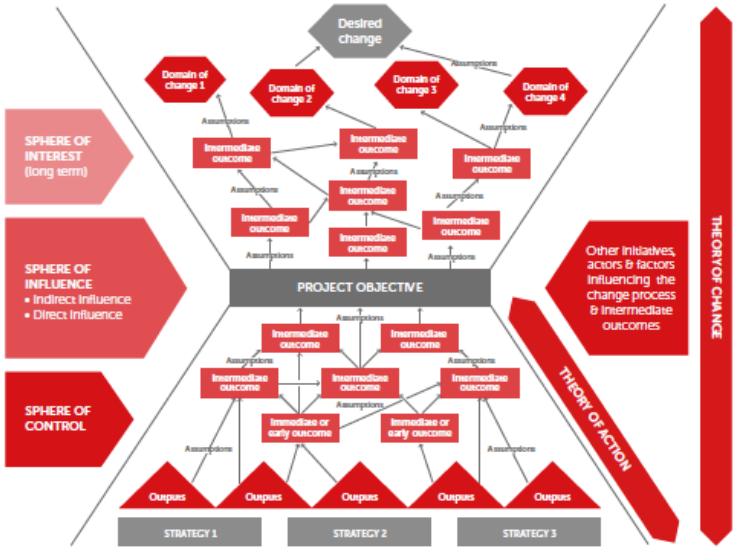


Figure 9: Three spheres: Control, Influence, Interest

Figure 10 (below): Change pathways with 'Three Spheres'



	See: https://knowledge.hivos.org/sites/default/files/publications/hivos_toc_guidelines_final_nov_2015.pdf Page 65
What are the assumptions of the method?	The method is based on the philosophy that articulating assumptions of how changes are envisaged to be achieved will enhance the chances for attaining them. Assumptions here refer to the facts, state of affairs and situations that are assumed and will be necessary considerations in achieving success. See: https://static1.squarespace.com/static/57a0dd1dbebafbfbfe80f9a7/t/5818db1e3e00be2eafd93a52/1478023968926/12b+-+Theory+of+Change+-+SP.pdf Assumptions stem from and represent values, beliefs, norms and ideological perspectives that inform our interpretation and understanding of reality, and our expectations of what will happen ToC, articulates assumptions underlying the strategic thinking of the design of a policy programme or project. • What do we assume about the needs, interests and behaviour of stakeholders and other key actors? • What do we assume about cause-effect relations in the logic of the change pathways? See: https://knowledge.hivos.org/sites/default/files/publications/hivos_toc_guidelines_final_nov_2015.pdf

Experience with applying the method	
Has the method been used before to capture impacts/value? If yes, in which project or context?	Examples of application of the Theory of Change: https://www.theoryofchange.org/library/toc-examples/
What are the strengths of this method?	• Set out how one set of outcomes leads to another, and can track progress towards the end goal. It is

	possible to identify what is working and what isn't. See: https://www.managementcentre.co.uk/theory-of-change-3/ • A clear and testable hypothesis about how change will occur that not only allows you to be accountable for results, but also makes your results more credible because they were predicted to occur in a certain way • A visual representation of the change you want to see in your community and how you expect it to come about • A blueprint for evaluation with measurable indicators of success identified • An agreement among stakeholders about what defines success and what it takes to get there • A powerful communication tool to capture the complexity of your initiative See: http://www.theoryofchange.org/what-is-theory-of-change/toc-background/toc-benefits/ • (1) revealing the diversity of actors associated with transdisciplinary approaches to sustainability, (2) unpacking the assumptions that frame how individuals understand and interpret complex problems, (3) helping to highlight important causal linkages, and (4) supporting the development of a systems perspective. See: https://www.ecologyandsociety.org/vol24/iss3/art20/#strength
What are the weaknesses of this method?	• (1) meaningfully grappling with complexity, (2) the challenge of articulating aspirational goals, (3) the difficulty in establishing clear boundaries for the theory of change, and (4) some practical and logistical challenges. See: https://www.ecologyandsociety.org/vol24/iss3/art20/#strength
Is there anything else you would like to share about this method?	There are several 'Theory of Change' variants and versions. Examples: NPC, BEAM, HIVOS.

MoRRI - Monitoring the Evolution and Benefits of Responsible Research and Innovation

General information about the method	
Method name:	*MoRRI – Monitoring the Evolution and Benefits of Responsible Research and Innovation*
Reference(s) to the method (incl. url):	MoRRI: The MoRRI project had the aim of establishing a monitoring system that measures how, where, and to what extent Responsible Research and Innovation (RRI) has become interwoven within European Research practices. http://morri-project.eu/ https://www.technopolis-group.com/morri/ Super MoRRI: The SUPER_MoRRI project aims to build on MoRRI through empirical and theoretical work. https://www.super-morri.eu/super-morri/
What is your relationship to this method?	*Please tick as many as applicable:* ● *Owner / creator* ● *Adapter / iterator* ● *User* ● *Interested in* ● *Other - ✓ - please specify :* Reviewer
What are the required inputs for using the method?	Using MoRRI requires extensive input data and information. Given the efforts required to collect primary data (survey fatigue, reluctance to provide information, etc.), more thinking is needed to develop a creative data collection and linking strategy that draws on existing data sources. In order to include various perspectives, this could include relevant Eurobarometer results from different survey waves to capture public opinion, Eurostat data, data collected though the SHE Figures series, but also

	to explore data mining techniques of institutional websites and repositories and assess the usefulness of this approach. Moreover, a potential wealth of information could be mined using the proposal and monitoring data from Framework Programme participation. Questions on ethics, gender and open access are included in the reporting requirements by each (potential) participant. Thus, a thorough analysis of this data opens up significant insights on a very large number of European research and innovation organisations. See: https://ri-links2ua.eu/object/document/649/attach/KI01188832AN_en.pdf
What are the conditions for using this method?	Not specified, but the indicators and project deliverables are publicly accessible.
Who is the intended user of the method?	Anyone who is interested in monitoring and evaluating the impacts of Responsible Research and Innovation (RRI) initiatives.

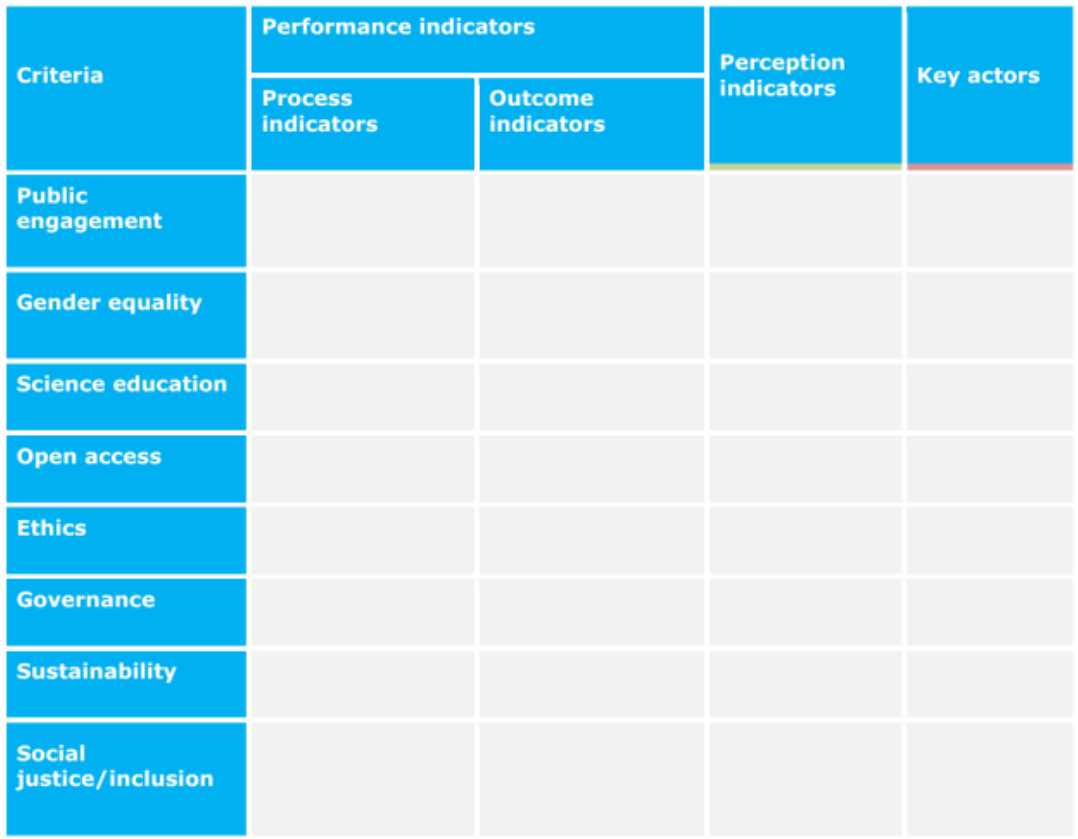
Details about capturing impacts & value	
What is the method designed for?	MoRRI's main objective is to provide scientific evidence, data, analysis and policy intelligence to support directly Directorate General for Research and Innovation (DG-RTD) research funding activities and policy-making activities in relation with Responsible Research and Innovation (RRI). MoRRI aimed at identifying and proposing 'indicators and other effective means to monitor and assess the impacts of Responsible Research and Innovation (RRI) initiatives, and evaluate their performance in relation to general and specific RRI objectives'.
From which perspective does this method capture impacts/value?	*Please tick as many as applicable:* ● *citizens,* ● *scientists* ✓ ● *commercial data aggregators*

	• *decision makers* ✓ • *policy makers* ✓

Which types of impact domains/categories does the method distinguish?	• *Society* ✓ (e.g. MoRRI's Social justice/inclusion and Science education dimensions)
	• *Governance* ✓ (e.g. MoRRI's Governance and Public engagement dimensions)
	• *Economy*
	• *Environment*
	• *Science* ✓ (e.g. MoRRI's Open access and Ethics dimensions)
	• *Others* ✓
	  ○ Sustainability
	  ○ Gender equality

How does this method *define* impact & value?	RRI is a concept that is recently gaining momentum but it still lacks agreement on its definition, content and details. Hence, MoRRI aimed to determine the scope and the benefits of RRI for Europe by: • Operationalising the concept • Developing a sound conceptual framework and associated methodology • Testing the potential of this methodology to allow monitoring the current state and short-term evolution of Responsible Research and Innovation and its socio-economic and democratic impacts. See: https://www.rri-tools.eu/-/morri-monitoring-the-evolution-and-benefits-of-responsible-research-and-innovation
How does this method serve to *capture* impact & value?	MoRRI aimed at "an initial scoping of the RRI dimensions (Gender equality, Public engagement, Science literacy and science education, Open access, Ethics, and as overarching dimension Governance). A heavy data collection exercise – including the collection of existing data and the launch of different surveys – was complemented by qualitative research in the form of case study analysis and the identification of benefits. Testing the data results for robustness and significance led to identification of core indicators and a clustering of EU countries. Conceptual ideas about the

	identification and measurement of benefits led to the development of impact pathways, which suggest that RRI dimension." The responsibility in RRI is a matter of outcomes as well as characteristics of the processes that lead to the outcomes, and so the expert group considered indicators both for outcomes and for processes. They focus on the interface between R&I and the society in which it takes place, and hence they considered indicators both of actors and action within the R&I sector, but also the perception by other actors and society in general. See: https://www.technopolis-group.com/report/final-report-summarising-insights-from-the-morri-project-d13/

	
What are the assumptions of the method?	Not clearly stated

Experience with applying the method	
Has the method been used before to capture impacts/value? If yes, in which project or context?	E.g. project GRACE (Grounding RRI Actions to Achieve Institutional Changes in European Research Funding and Performing Organisations). GRACE adopted an impact assessment approach, to oversee and monitor the project processes and impacts, applying MoRRI and SDGs indicators, and SwafS KPIs.
What are the strengths of this method?	Distinction between process, outcome and perception-related indicators is a very important conceptual strength of this Method.
What are the weaknesses of this method?	Using MoRRI requires extensive input data and information. 'Citizen Science initiatives' are mentioned as an example for process indicators of the event/initiative making and attention creation category in the public engagement category, which is confusing.
Is there anything else you would like to share about this method?	

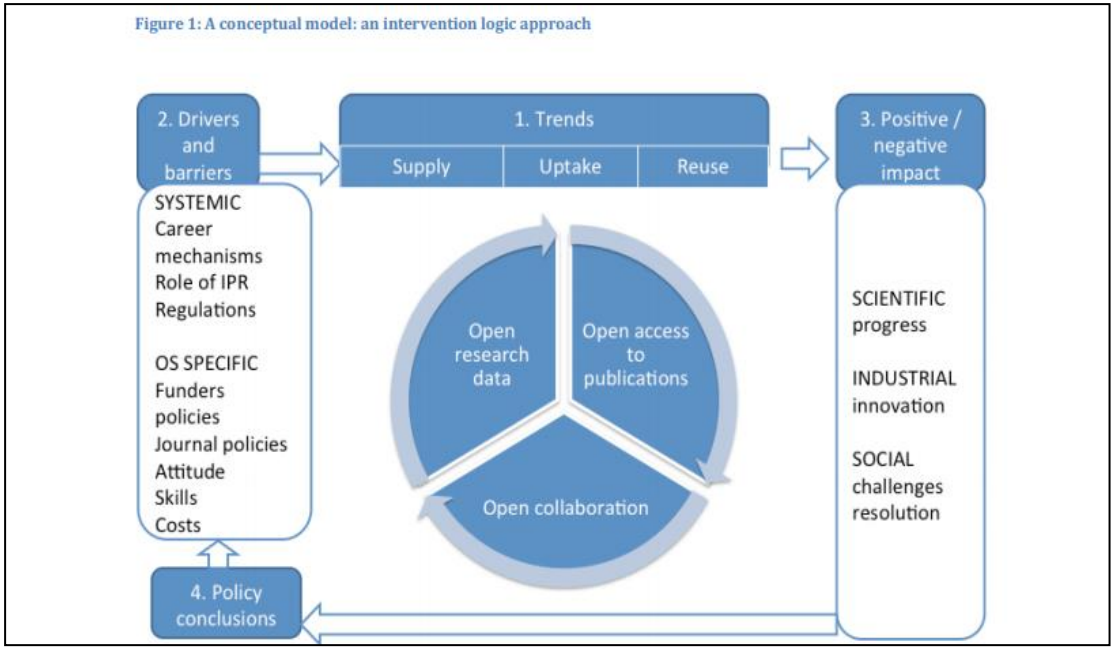
Open Science Monitor

General information about the method	
Method name:	Open science Monitor (OSM)
Reference(s) to the method (incl. url):	See the link: https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science/open-science-monitor/about-open-science-monitor_en See document: Open Science Monitor. Updated Methodological Note
What is your relationship to this method?	*Please tick as many as applicable:* ● *Owner / creator* ● *Adapter / iterator* ● *User* ● *Interested in* ● *Other - please specify:* ✓ Reviewer
What are the required inputs for using the method?	Not clearly defined. "We need the input of the open science community to improve the indicators and identify new data sources." See: https://www.makingspeechestalk.com/ch/Open_Science_Monitor/
What are the conditions for using this method?	Unclear. No specific requirements identified from the documentation.

Who is the intended user of the method?	See: Open Science Monitor. Updated Methodological Note. - Researchers (Professional and citizens researchers) - Research Institutions (Universities, other publicly funded research institutions, and informal groups) - Publishers (Traditional publishers, New OA online players) - Service providers (Bibliometrics and new players) - Policy makers (At supranational, national and local level) - Research funders (Private and public funding agencies)

Details about capturing impacts & value	
What is the method designed for?	This method should not be used as an (impact) assessment tool. The Open Science Monitor has been created to get some **quantitative and qualitative** insights on the ongoing development of **open science practices**. The Open Science Monitor is not an assessment tool. The European Commission (EC) may draw conclusions from the quantitative and qualitative trends in open science and its drivers **to propose new policies** for fostering open science. The fact that our current data-infrastructures are not all open and transparent, let alone enable open data usage. Therefore, the EC wants to establish **a European Open Science Cloud**, which will make eventually open data, open data sharing, and data re-use possible. Specific mention to **citizen scienc**e indicators: N. Projects in Zooniverse and Scistarter *(Source: Zooniverse and Scistarter)* N. Participants in Zooniverse and Scistarter *(Source: Zooniverse and Scistarter)*

	See: https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science/open-science-monitor/about-open-science-monitor_en Description of the model. The central aspect of the model refers to the analysis of the open science **trends** and is articulated alongside three dimensions: **supply, uptake** and **reuse** of scientific outputs. On the left side of the chart, the model identifies the **key factors** influencing the trends, both **positively** and **negatively** (i.e. drivers and barriers). Both drivers and barriers are particularly relevant for **policymakers.** The right side of the chart in the model, illustrates the **impacts** of open science to research or the scientific process itself; to industry or the capacity to translate research into marketable products and services; to society or the capacity to address societal challenges. See: Open Science Monitor. Updated Methodological Note.

	
From which perspective does this method capture impacts/value?	*Please tick as many as applicable:* ● *citizens,* ✓ - Citizens researchers ● *scientists*✓ - Researchers - Research Institutions (Universities, other publicly funded research institutions, and informal groups) ● *commercial data aggregators* ● *decision makers* ● *policy makers*✓ (At supranational, national and local level)

	• *Others* ✓ - Publishers (Traditional publishers, New OA online players) - Service providers (Bibliometrics and new players) - Research funders (Private and public funding agencies) See: Open Science Monitor. Updated Methodological Note.
Which types of impact domains/categories does the method distinguish?	• *Society*✓ - Social challenges (society) • *Governance* • *Economy* • *Environment* • *Science*✓ • *Others*✓ - Industrial innovation See: Open Science Monitor. Updated Methodological Note. See Figure1.
How does this method *define* impact & value?	A wide variety of data sources have been used, depending on availability, such as, **bibliometrics, Online repositories, surveys, ad hoc analysis in scientific articles or reports and data from specific services**. See: Open Science Monitor. Updated Methodological Note. Key indicators per trends: ○ Open access to publications - Green and gold open access (bibliometrics), Open access policies (funder and journals) ○ Open research data – Open data policies (funders and journals), open data repositories, open data adoption and researchers' attitudes ○ Open collaboration – Open code, Open scientific hardware, **citizen science**, altmetrics

	See: https://www.makingspeechestalk.com/ch/Open_Science_Monitor/ See: Open Science Monitor. Updated Methodological Note. Table 1.
How does this method serve to *capture* impact & value?	The methodological approach is mainly focus on adding different Open Access (OA) labels to the publications covered in the **Scopus database**, using **Unpaywall** to establish this OA status of scientific publications. Implementing **Unpaywall** data, it is important to consider **Gold, Green, Hybrid OA** and **Bronze** categories. The following OA indicators are calculated: - **Total number of publications**: this is the overall number of publications, which is used as the denominator for the calculation of shares of OA. - **Total (and share of) OA**: the overall number (and share) of OA available publications (covering all types of OA recorded by Unpaywall - namely **Gold, Green, Hybrid and Bronze**). With this we intend to be fully in line with the Unpaywall data in the disclosure of OA availability. - **Green OA and Gold OA**: in this data delivery we report publication counts (and shares) of **Green** and **Gold** OA publications **separately**. Different types of OA have different interests depending on the different stakeholders. The analysis has been restricted to only those publications having a DOI (digital object identifies) in **Scopus**, since currently **Unpaywall** only provides OA labels to publications with DOIs. See: Open Science Monitor. Updated Methodological Note. Annex 1 - We will use Unpaywall data alongside Scopus data. Unpaywall has a very large footprint and will increase the coverage of the Open Science Monitor.

	- We use multiple sources when possible for double-checking purposes. We will do a comparison of results obtained when using **Scopus** or **Web of Science**, and we're exploring the possibility to do the same with **Plum** and **Almetric.com** - We clarify that data from Scopus can be made available to individual academic researchers to assess or replicate the OSM methodology, under the standing policy of Elsevier to permit academic research access to Scopus data. See: https://medium.com/@osimod/an-updated-methodology-for-the-open-science-monitor-52db33262e05
What are the assumptions of the method?	Not clearly stated

Experience with applying the method	
Has the method been used before to capture impacts/value? If yes, in which project or context?	There are many case studies, but here are a few examples: 1. **Open Research Policies in the United Kingdom:** Open research policies in the UK with respect to open access and open data. 2. **The Netherlands' Plan on Open Science:** Three key ambitions for open science: 100% open access to publications, research data made optimally suitable for reuse, and evaluation and valuation systems to recognize and reward researchers. 3. **Finnish Open Science and Research Initiative:** An initiative with an aim of making Finland one of the leading countries in open science and research by the year 2017. It was carried out in co-operation with ministries, research and higher education institutions and research funders. 4. **Expanding Data Sources for the Measurement of Open Science:** A comparison between the outcomes of the first analysis on Open Access publishing as performed for the Open Science Monitor and the results of a study performed for another European project, Key Technology

	Domains (KTD). 5. **Social Science Open Access Repository:** A database of open access social science research articles. 6. **Reproducibility Project:** A collaborative effort to replicate 100 psychology experiments. 7. **Zenodo:** A general-purpose open access repository of research data and journal publications. 8. **The white rabbit** (link): how to foster open source hardware for science. It is an example on how CERN managed to transform the open source software model to capital-intensive innovations. See: https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science/open-science-monitor/trends-open-access-publications_en#percpublications
What are the strengths of this method?	The use of **different** and **diverse** databases, such as, Scopus, Web science, Unpaywall, Sherpa Juliet, Sherpa Romeo, Cos.io, Vasilevsky et al, 2017, Re3data, Bibliometrics: Datacite, S2016 and 2018 survey by Elsevier, Base-search.net, OpenDOAR, Scientific social networks, Mozilla Codemeta, Programmableweb, Stodden 2013, Zenodo, Base, CodeOcean, Open Hardware repository, Zooniverse and Scistarter , Scopus, Mendeley & Plum. However, new data sources need to be used! The methodology is continuously being reviewed. See: Open Science Monitor. Updated Methodological Note. Open science may be beneficial for many reasons including **reducing duplication** of research efforts and equally **enabling the replication** of research results were needed. See: A framework to monitor open science trends in the EU
What are the weaknesses of this method?	There were several criticisms of using **Elsevier** to gather data through the survey, but no valid alternatives of comparable quality and cost/efficiency were proposed.

	New indicators and sources are needed. See: Open Science Monitor. Updated Methodological Note. Consequences implied by the **subcontractor choice** (Coverage bias, Major conflict of interest, Elsevier's competitors discriminated, Non-reproducibility) See: https://www.ouvrirlascience.fr/feedback-on-ec-open-science-monitor-methodological-note/ There is a big definitional issue when defining **citizen science** concept. What does 'citizen science' means? Including citizen science in the monitor would by necessity limit the number of dimensions that can be presented. Therefore, citizen science should be presented more **qualitatively** than the other characteristics See: A framework to monitor open science trends in the EU
Is there anything else you would like to share about this method?	The Open Science Monitor will also support European Commission initiatives such as the **Open Science Policy** Platform and the **Open Science Cloud**. The Open Science Policy Platform is a group that advises the Commission on how to develop open science **policy** and the Open Science Cloud (EOSC) is a cloud for research data in Europe. See: Open Science Monitor. Updated Methodological Note

OpenUp

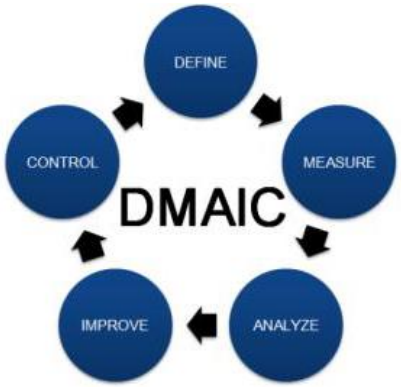
General information about the method	
Method name:	OpenUp
Reference(s) to the method (incl. url):	OpenUP addresses key aspects and challenges of the currently transforming **science landscape** and aspires to come up with a cohesive framework for the **review-disseminate-assess** phases of the **research life cycle** that is fit to support and promote **Open Science**. See: https://cordis.europa.eu/project/rcn/203537/factsheet/en
What is your relationship to this method?	*Please tick as many as applicable:* ● *Owner / creator* ● *Adapter / iterator* ● *User* ● *Interested in* ● *Other - please specify:* ✓ Reviewer
What are the required inputs for using the method?	Not clearly defined
What are the conditions for using this method?	Creative Commons Attribution 4.0 International License See: http://creativecommons.org/licenses/by/4.0/ See: https://www.openuphub.eu/terms-conditions
Who is the intended user of the method?	Policy recommendations derived by the project: **Policy makers, institutional decision makers, librarians, research funders and alternative metrics providers** See: Deliverable 1.5 (page 10)

	Stakeholders engaged in the research cycle are: Researchers, young scholars, educators, publishers, R&I project members, policy makers & funders, IT providers and citizens. See: https://www.openuphub.eu/about and Deliverable 2.1 (Table 4)

Details about capturing impacts & value	
What is the method designed for?	The exponentially growing research output, the increasing demand for a more **open, transparent and reproducible science**, as well as apparent shortcomings in present quality assurance and evaluation methods require **re-thinking** how the **quality of research products** is assessed. Traditional ways of publication and evaluation do not satisfy the needs of this changing landscape. OpenUP aspired to identify and spread the **review-disseminate-assess mechanisms** fit for the evolving practices of Responsible Research and Innovation (RRI) in an Open Science context. Therefore, this method tries to adopt an **innovative approach** for releasing and disseminating research results related to peer review, innovative dissemination, and alternative metrics in Open Science. See: https://cordis.europa.eu/project/rcn/203537/reporting/en
From which perspective does this method capture impacts/value?	*Please tick as many as applicable:* ● *citizens,* ● *scientists* ✓ (e.g. universities) ● *commercial data aggregators* ● *decision makers* ● *policy makers* ● *Other* ✓ *(Research organizations, NGOs)* See: Deliverable 1.5 (page 7)

Which types of impact domains/categories does the method distinguish?	• *Society*
	• *Governance*
	• *Economy*
	• *Environment*
	• Sciences✓
	  ○ social sciences
	  ○ life sciences
	  ○ energy
	• Others: ✓
	  ○ arts and humanities
	  ○ gender: Gender aspect was addressed horizontally in OpenUP project and its activities.
	
	Engage with research communities from: life sciences, social sciences, energy, arts and humanities
	See: https://cordis.europa.eu/project/rcn/203537/factsheet/en

How does this method *define* impact & value?	The impact or value is defined based on openness of processes and results such as open access, open data, open reproducibility, open science evaluation, open science policies, and open science tools.
How does this method serve to *capture* impact & value?	3 key themes of the OpenUp: **Peer review, innovative dissemination, and impact assessment.** **A) Peer review:** **DMAIC (Define, Measure, Analyse, Improve, Control)** methodology cycle has been used to mapping out the process of transforming the landscape.



This methodology serves a dual purpose here: (1) the framework of DMAIC structures the analysis process, and (2) the landscape scan is understood as a broadened process of mapping the existing **peer review methods and analyzing/categorizing** the emerging alternative methods/tools.

In measure phase-> OpenUp survey to capture current perceptions and practices in peer review, dissemination of research results and impact measurement among European researchers.
See: Deliverable 3.1. (Page 9) for broader information about each phase.

Categories of **alternative review tools/methods**. 4 categories:

- open peer review solutions offered by publishers, publishing platforms, or journals
- independent peer review services
- repository related peer review solutions
- review applications, and commenting tools

Alternative review methodologies:

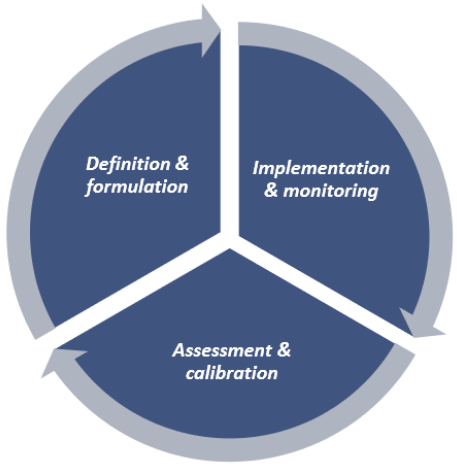
- Open peer review (OPR)
- Open peer/public commentary
- Post-publication peer review (PPPR)

- Decoupled peer review
- Portable/Cascading review
- Machine aided review
- Alternative review of non-textual publications, like software, data and video

Conclusion: the alternative review methodologies contribute to a more democratic, transparent and community-based knowledge discovery and dissemination.
See: Deliverable 3.1. (Page 30-42)

B) Innovative dissemination:

Innovative dissemination is the one that goes beyond traditional academic publishing (e.g. academic journals, books, or monographs), conferences and workshops.



There were analysed (10) case studies where innovative dissemination methods were found.
See: Deliverable 4.1 (Page 20). Dissemination lifecycle phases in the OpenUp project.

	• Main and specific dimensions.
	  ○ Why?: Purpose of dissemination
	  ○ What and How: Dissemination activities, Dissemination outputs, Tools used, Disseminated materials, Media formats
	  ○ When?: Start of dissemination, Dissemination phases
	  ○ Who?: Who initiated the dissemination? Target Audience, Reception and Impact
	  ○ Effort: Quality of materials, Estimated cost
	  ○ Openness: Openness of dissemination, Interoperability, Connection to peer review and metrics
	  ○ Gender: Distribution of gender in project, Representation of gender in materials
	• For example, **Citizen science** related projects: Galaxy zoo project, Transcribe Bentham, Innovations in Scholarly Communications.
	See: Deliverable 4.1 (page 36)
	
	• Innovative dissemination **framework and toolbox**. It gives an overview of innovative dissemination **practices** and **tools** for their particular situation, complete with best practice examples from the case studies. It also includes **guidelines** and **checklists** on topics such as openness and gender.
	See: https://www.openuphub.eu/disseminate/tools
	
	• **Methods**: Answering questions, Blogging, Collaborative writing, Creating a video/podcast, Creating a website, Crowdsourcing, Editing Wikipedia, Gamification, Giving a talk, Giving interviews, Hosting a podcast/webcast, Issuing a press release, Live streaming, Performance, Popular science writing, Posting to social media, Providing a simulation, Providing a tutorial, Release a policy/practice brief, Releasing educational material, Setting up a Science Shop/FabLab, Sharing scientific outputs, Storytelling, Visualization
	• **Media**: Video, Play, Music, Text, Images, Video, Audio, Software, Photos Slides
	See: Deliverable 4.1 (Table 20) Mapping of **innovative dissemination methods** to media and tools/channels

	C) Metrics and indicators (impact assessment) **Data Sources** used in Altmetrics can be assigned to the following **categories**: • social bookmarking: CiteULike, Mendeley, Delicious • video, photo and slide sharing: Youtube, Vimeo, Slideshare, Flickr, Daily Motion • Social networks: Facebook, Google+, LinkedIn, Academia, ResearchGate • Blogging: Nature blogs, PloS blogs, Scientific American blogs, Research Blogging, Nature • microblogging: Twitter, Sina Weibo, Tumblr • recommendation and review systems: F1000, F1000Prime, Reddit, Publons, Amazon reviews, Goodreads • Q & A: Stack exchange, other • Online digital libraries: PMC, Europe PMC, BioMed Central, PubMed, Scopus, Web of Science, CrossRef, Fighshare, arXiv, WorldCat, institutional repositories, RePec, EBSCO, SSRN, EPrints, dSpace, USPTO Patents, Lexis, CRIS • Source code repositories: Github, Sourceforge, Bitbucket • Dataset repositories: Dryad, Datacite, ADSSource code repositories • Online publishers: PLoS, Open Edition, Copernicus • Search engines and blog aggregators: Science seeker • Others: ORCID, Google code, Google patents, WIPO, bit.ly, COUNTER Different types of **providers**: • Primary aggregators: Article Level Metrics (ALM), Altmetric.com • Secondary aggregators: Plum Analytics, Impactstory, webometrics, Kudos, • Tertiary aggregators: Snowball metrics Altmetric providers. Deliverable 5.1 (Table 1), (Figure 3) OpenUP proposes a new, open approach to **impact metrics** in a new platform offering a series of new impact data services. It will include: • Increased coverage • New citation standards, and methods to link data

	• Collection of impact data OpenUP Impact Data Services Platform will require close collaboration with the **research community, publishers, bibliometric providers, aggregators, and repositories** - The OpenUP Impact Data Platform receives the impact data from bibliometric providers, aggregators and repositories, consolidates and analyses the data and generates **publication** and **non-publication** related metrics. Where appropriate, create indexes **for research outputs like methodologies**, cell lines, and equipment, the platform may use Natural Language Processing, and Text and Data Mining algorithms. - Impact data **APIs** (i.e. citation and citation metadata) are already provided by publishers and bibliometric providers today. The next step is for the platform to consolidate the data, remove duplicates and aggregate data from different sources into a single view. See: Deliverable 5.5 (Page 32) • **Policy recommendations:** It provides well-defined actions to integrate new methods and practices beyond Open Access publishing (i.e. open peer review, open research data, innovative dissemination, and alternative metrics) into the ongoing policy discussions. Recommendations: 1. Run pilots that implement OPR practices to generate evidence 2. Create incentives for and strengthen monitoring of innovative research dissemination 3. Increase awareness of and train researchers on alternative metrics 4. Exploit ongoing policy developments at EU and national levels and integrate OPR, innovative dissemination and alternatives metrics practices 5. Fund further research on the impact of Open Science practices for solving gender and diversity issues See: Deliverable 7.3 (Page 14-17)
What are the assumptions of the method?	Not clearly stated

Experience with applying the method	

Has the method been used before to capture impacts/value? If yes, in which project or context?	Through the **seven** pilot case studies OpenUP demonstrated the applicability of selected methods and tools that make the lifecycle of research more transparent and open.
	
	Innovative **peer review** applied to specific contexts
	- Pilot 1: Open Peer Review for Conferences
	  ○ Goal: Test an open peer review workflow in a conference setting
	- Pilot 2: Open Peer Review for Research Data
	  ○ Goal: Investigate the applicability of (open) peer review to research data in disciplines related to Social Sciences
	- Pilot 3: A data journal for the Arts and Humanities
	  ○ Goal: Define a framework for a data journal in the Humanities and provide a related action plan
	
	Innovative dissemination of research output in specific contexts
	- Pilot 4: Transferring the research lifecycle to the web
	  ○ Goal: Investigate whether qualitative research, in particular data analysis and data collection, can be transferred to open online groups
	- Pilot 5: Addressing & reaching businesses and the public with research output
	  ○ Goal: Analyse and test how disseminated research results from the Energy area can be made more interesting, appealing, and usable for target audiences beyond the research community
	
	Measuring impact of research output applied to specific contexts
	- Pilot 6: Reflexivity of metrics on medical research and dissemination practices
	  ○ Goal: Engage with and reflect on current practices and stances of handling data in the biomedical research enterprise, in order to identify barriers and enablers for Open Data, and to derive recommendations for their incentivisation (or possible metrification).

	- Pilot 7: Piratical demand as a form of impact indicator and reaching unexpected audiences - Goal: Conduct a quantitative, statistical and econometric analysis of large-scale datasets on the supply of and demand for scholarly works on various illegal platforms See: Deliverable 6.1. (Page 11-18) and Deliverable 6.3 (Table 1)
What are the strengths of this method?	Presented SWOT analysis for: Open peer review, Innovative Dissemination, and Open Metrics. See: Deliverable D2.4 -Updated Exploitation and Sustainability Plan (page 10- 13) **Open peer review** • Consistent with Open Science goals of greater transparency, flexibility, inclusivity and accountability. • Offers solutions to the drawbacks of established review systems. • Credits reviewers in the publication **Innovative Dissemination** • Increasingly participatory and multi-directional • A wealth of approaches going beyond traditional academic publishing and good practices. • Integral to Open Science • Uses big data, state-of-the-art technology and communication channels • "Wisdom of the crowd" **Open Metrics** • Evolving new methods in evaluating the impact of scholarly output • Measures scholarly influence and impact on other audiences as well • Measures different types of research objects (e.g. data, software tools and applications) • Enable the same objects to be measured by multiple signals (e.g. comments, tweets, likes, views, downloads) • Reflects measurements faster than conventional metric See: Deliverable 3.1. (page 23) – Open peer review

	See: Deliverable 5.1 (page 7), (page38-39) – Assessment metrics
What are the weaknesses of this method?	Presented SWOT analysis for: Open peer review, Innovative Dissemination, and Open Metrics. See: Deliverable D2.4 -Updated Exploitation and Sustainability Plan (page 10- 13) **Open Peer Review** • Conflicting benefits and drawbacks for different flavours of OPR (open identity, open reports, open participation, etc.) • Very little evidence to support or refute benefits and drawbacks • No strong movement in its favour • Unclear impact on gender and diversity issues **Innovative Dissemination** • Weak uptake despite perceived enthusiasm • Low uptake due to lack of time, insufficient funding, lack of pressure and incentives to engage in Innovative Dissemination • Lack of critical mass. No science equivalent of Facebook. • May weaken traditional forms of collaboration (Facebook is not a substitute for a conversation) • Weak link between dissemination and research impact on science **Open Metrics** • Ease to game metric-based evaluations • Low uptake in sharing other types of research objects distorts results • Lack of open metric standards • Limited access to the raw data • Underlying data mostly owned by commercial companies See: Deliverable 3.1. (page 23) – Open peer review See: Deliverable 5.1 (page 7), (page38-39) – Assessment metrics

Is there anything else you would like to share about this method?	A platform for everyone with an interest and/or involved in 'open science'. News, reading tips, tools and events are exchanged concerning all phases of the research life cycle. OpenUP seeks a dialogue about new methods, indicators and tools for quality assessment, dissemination of knowledge and measuring impact. See: https://www.openuphub.eu

DEFRA indicators

General information about the method	
Method name:	UK Biodiversity Indicators 2019 Revised* *The indicators are not an impact assessment method but could still give inspiration for indicators for the MICS project.
Reference(s) to the method (incl. url):	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/850369/UKBI_2019_rev2.pdf
What is your relationship to this method?	*Please tick as many as applicable:* ● *Owner / creator* ● *Adapter / iterator* ● *User* ● *Interested in* ✓ ● *Other - please specify:*
What are the required inputs for using the method?	The assessment method requires specific data collection. The following list is indicative but not exhaustive: • Survey results about public perceptions • Data from previous assessments (the indicators require comparison over time) • Data from other research/national surveys
What are the conditions for using this method?	© Crown copyright 2019 Copyright in the typographical arrangement and design rests with the Crown. This publication (excluding logos) may be reproduced free of charge in any format or medium provided that it is reproduced accurately and not used in a misleading context. The material must be acknowledged as Crown.

Who is the intended user of the method?	UK decision makers. The method assesses environmental impact at the national scale.

Details about capturing impacts & value	
What is the method designed for?	The method is not really designed to capture the impact of a single policy or project. Rather it measures the change in biodiversity at a national scale.
From which perspective does this method capture impacts/value?	*Please tick as many as applicable:* ● *citizens,* ● *scientists* ● *commercial data aggregators* ● *decision makers* ✓ ● *policy makers* ✓ ● *other:…*
Which types of impact domains/categories does the method distinguish?	● *Society* ✓ ● *Governance* ● *Economy* ✓ ● *Environment* ✓ ● Science ✓ ● Others
How does this method *define* impact & value?	The document does not define impact or value as it is not an impact assessment method. The method assesses indicators of change in 5 areas: • The mainstreaming of biodiversity in society and government • The direct pressures on biodiversity • The status of biodiversity • The benefits from biodiversity

	• The availability of data decision making and funding for action
How does this method serve to *capture* impact & value?	There are 49 indicators. For four of these the method for assessment is still under development. The other 45 indicators each have a separate method of capturing and analysing data. Many of the indicators aggregate data from other sources.
What are the assumptions of the method?	This is not an impact assessment method, it measures change in biodiversity. If it were to be used as an impact assessment of a project, the major assumption would be that the change in biodiversity could be attributed to the project in question.

Experience with applying the method	
Has the method been used before to capture impacts/value? If yes, in which project or context?	No, the method has only been used to assess the overall status of biodiversity in the UK, not to assess the impact of a project.
What are the strengths of this method?	Provides rigorous methods for assessing impact on biodiversity.
What are the weaknesses of this method?	• Not designed for measuring impact. Might be hard to translate from the national scale to the relevant scale of the project and to attribute the changes measured in biodiversity to the outcomes of a project. • Takes a lot of time/resource to collect the information needed for each indicator e.g. there are whole surveys/measurements required for each individual indicator.
Is there anything else you would like to share about this method?	

Annex 3 – Reviewed Citizen Science literature

Informal Education and Outreach Framework

- This report by Friedman (2008) includes the Informal Education and Outreach Framework of the National Science Foundation (NSF) of the United States. The proposed framework distinguishes between six major categories of outcomes for Informal Science Education (ISE) programmes, namely 'knowledge, awareness, and understanding', 'engagement and interest', 'attitudes', 'behaviour', 'skills' and 'other'. These categories refer to impact of ISE programmes on society. The higher aim of this framework is to enable creating a 'big picture' of the benefits of the ISE programs. This is made possible by providing a common structure that allows individual projects to determine and report their impact; reports that can be aggregated for creating a collective picture of impacts if ISE programs. This framework (intentionally) does not directly provide in-depth information about evaluation techniques or the 'how-to' aspect of evaluation, but provides several references for interested readers. The report includes definitions of 4 types of evaluation, namely, summative, front-end, formative and remedial evaluation. The proposed framework can be applied to both projects that target public audiences by means of an informal STEM education and outreach, as well as projects that target professional audiences.

Table: The Informal Education and Outreach Framework - Friedman (2008)

Impact Category	**Public Audiences**	**Professional Audiences**
Awareness, knowledge or understanding (of)	STEM concepts, processes, or careers	Informal STEM education/ outreach research or practice.
Engagement or interest (in)	STEM, concepts, processes, or careers	Advancing informal STEM education/outreach field
Attitude (towards)	STEM-related topic or capabilities	Informal STEM education/ outreach research or practice
Behavior (related to)	STEM concepts, processes, or careers	Informal STEM education/ outreach research or practice
Skills (based on)	STEM concepts, processes, or careers	Informal STEM education/ outreach research or practice
Other	Project specific	Project specific

Strands of science learning

- The National Research Council (NRC) is part of the U.S. National Academy of Sciences and U.S. National Academy of Engineering and its main function is on furthering knowledge and advising the federal government. In this publication (NRC 2009), NRC proposed to use six 'strands of science learning' as a framework for evaluating science learning in Informal Environments. These strands are in short, 'interest', 'understanding', 'science exploration', 'reflection', 'participation in science' and 'scientific identity'. This publication also provides guidelines on methods for researching each strand. These strands focus on learning aspects and thus impacts on society.

Triple C

- This report (Bonney et al., 2009a) distinguishes between three major types of public participation in scientific research (PPSR) projects; namely, Contributory, Collaborative and Co-created projects. This report proposes a rubric for analysing the results of PPSR projects based on the evaluation framework Friedman (2008). The proposed rubric describes potential impacts of PPSR projects in terms of developing understanding and knowledge, enhancing engagement or interest, improving skills, changing attitudes, and changing behaviour within participants. This rubric is tested for analysing the impact of ten projects including five Contributory, three Collaborative, and two Co-created projects. Similar to Friedman (2008), this conceptualization is relevant for assessing learning outcomes and impacts of projects and hence relates to societal impacts.

Table: Rubric for analysing the results of PPSR projects - Bonney et al. (2009a)

Table 2. Assessment Rubric for Describing Impacts of Public Participation in Scientific Research Projects				
Impact category	Stated goal	Potential indicators	Measured outcomes	Inferred outcomes
Awareness, knowledge, and/or understanding (of) [1]				
Content (Concepts)				
Process				
Nature of science				
Careers				
Community				
Engagement or interest (in) [2]				
Content (Concepts)				
Process				
Community				
Careers				
Skills [3]				
Asking questions				
Study design				
Data collection				
Data analysis				
Data interpretation				
Discuss results				
Disseminate results				
Using technology				
Writing				
Community				
Attitudes [4]				
Toward science				
Toward content				
Toward people				
About activities				
Toward species				
About careers				
About theories				
About community				
Behaviors [5]				
Time engaged				
Time outdoors				
Lifestyle changes				
Within community				
Community involvement				
Citizen action				
Responsible environmental behavior				
New participation				
Other [6]				
Social capital				
Community capacity				
Economic impact				

Tool for Expanding Science Knowledge & Scientific Literacy

- This publication proposes two meta categories of outcomes for Citizen Science projects, namely scientific outcomes and contribution to scientific literacy. A number of indicators are proposed for measuring each category. The authors believe that contribution of CS to science is reasonably straightforward and propose seven possible indicators for measuring this contribution that include (1) Numbers of papers published in peer-reviewed journals, (2) Numbers of citations of results, (3) Numbers of researchers publishing citizen science research papers, (4) Numbers and sizes of grants received for citizen science research, (5) Size and quality of citizen science databases, (6) Numbers of graduate thesis completed using citizen science data, and (7) Frequency of media exposure of results. Measuring improvement in public scientific literacy is considered to be more challenging, nevertheless, seven possible indictors are also proposed for measuring this type of impact that include (1) Duration of involvement by project participants, (2) Numbers of participant visits to project Websites, (3) Improved participant understanding of science content, (4) Enhanced participant understanding of science process, (5) Better participant attitudes toward science, (6) Improved participant skills for conducting science, and (7) Increased participant interest in science as a career.

Generic logic model for describing results of PPSR projects

- The major conceptual contribution of this book chapter by Philips et al. (2012) is a framework that combines the six categories proposed by Friedman (2008) related to PPSR and a logic model that distinguishes between inputs, activities, outputs, outcomes and impacts. This publication also includes an example application of the proposed framework for evaluating the NestWatch program of the Cornell Lab of Ornithology. Similar to Friedman (2008), the focus of the proposed framework is on evaluating learning outcomes and therefore it is relevant for assessing societal changes. Nevertheless, some of the proposed indicators of outputs, outcomes and impacts (e.g. data and improved science-society relationship) are also relevant for the science domain.

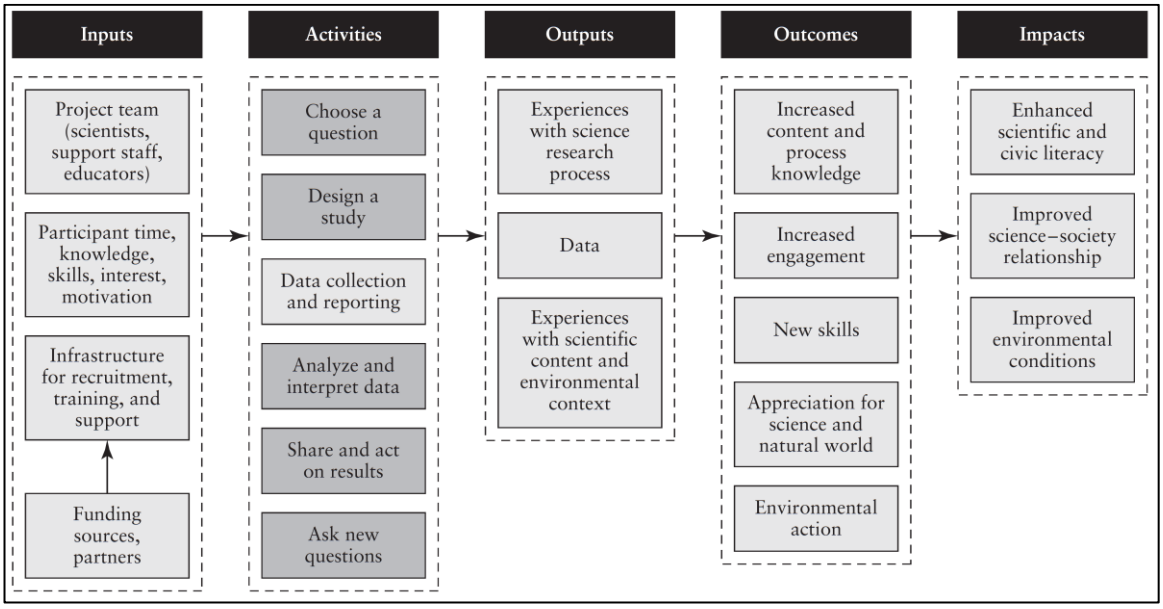


Figure: Generic logic model for describing results of PPSR projects - Phillips et al. (2012)

- Phillips et al. (2014) is a user guide that is designed for practitioners who want to evaluate outcomes of Citizen Science projects or PPSR projects. The content of this user guide is pretty much based on previous studies by Phillips et al. (2012) and Bonney, et al. (2009a&b) but it provides much more detailed information and useful forms for practical use and distinguishes between outputs, outcomes and impacts of Citizen Science projects of for programmes and for participants. This user guide has references to logic framework approach and Theory of Change and it provides more refined categories of output and outcome. Moreover, it includes a comparison between the categories of learning outcomes proposed by Friedman (2008) and National Research Council (2009), and based on that, a detailed framework for evaluating individual learning outcomes. Phillips et al. (2018) also includes a structured review of 327 citizen science project websites. For each project, information such as project name, URL, contact information, general goal statements, learning objectives or desired outcomes (if any), and potential indicators of learning was collected and analysed.

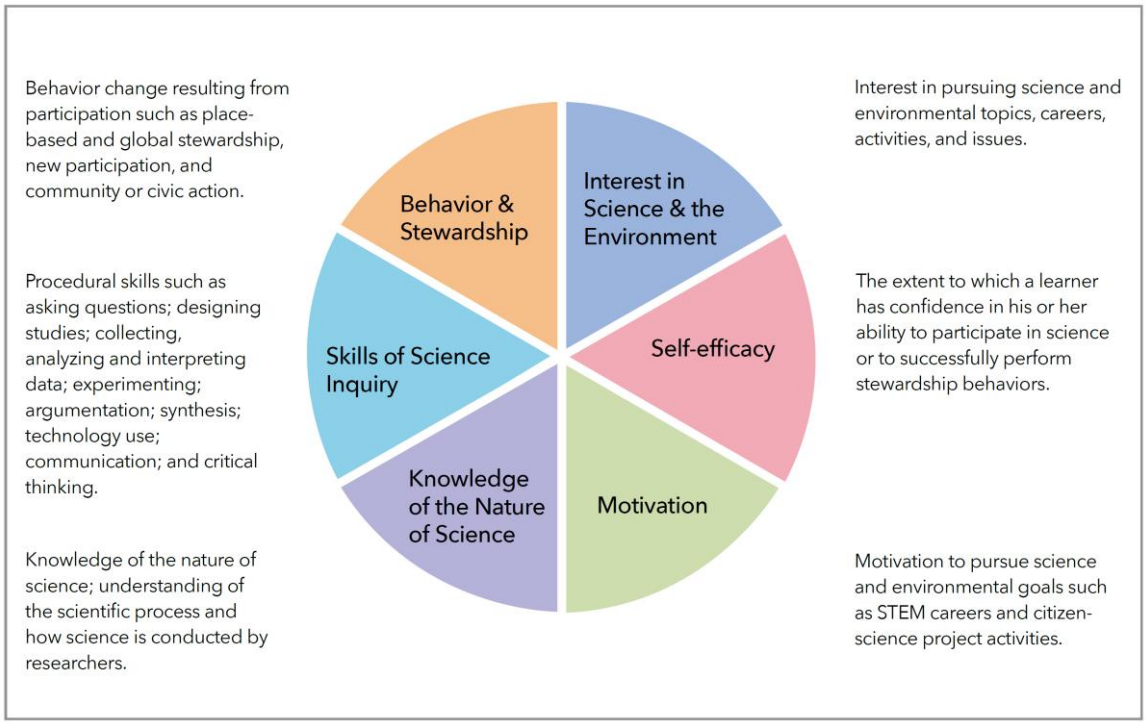


Figure: Guiding framework for evaluating individual learning outcomes from Citizen Science projects - Phillips et al. (2014a)

5 Cs

- Building on Bonney, et al. (2009a), Shirk et al. (2012) distinguish between five types of PPSR projects; namely, Contractual, Contributory, Collaborative, Co-Created, and Collegial projects. The conceptual framework proposed in this publication is also based on a logic model; however outcomes of PPSR projects are categorized into three distinct groups that include outcomes for individuals, science and social–ecological systems. Based on the categories defined below the

social–ecological systems, it is evident that this outcome category refers to governance of such systems.

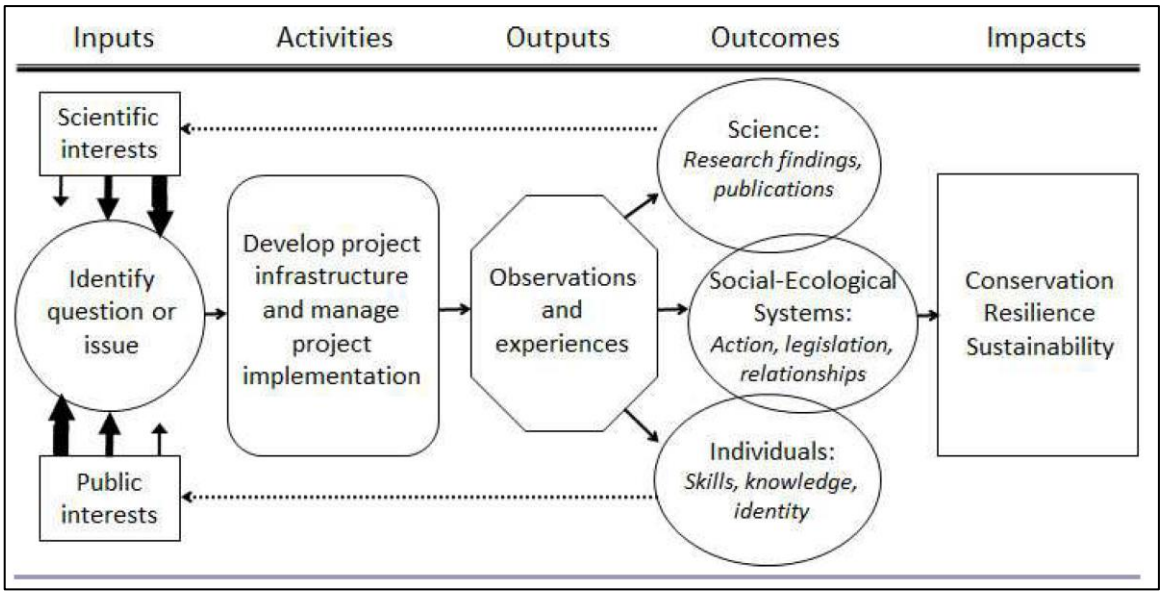


Figure: Logic framework for PPSR projects - Shirk et al., (2012)

-

Framework for evaluation of citizen-science programs

- Jordan et al. (2012) proposed a framework with three main categories (and nineteen sub categories) of outcomes for Citizen Science projects. The three main categories are individual learning outcomes, programmatic outcomes, and community-level outcomes. These proposed (sub)categories refer to societal, scientific and economic impact of Citizen Science projects.

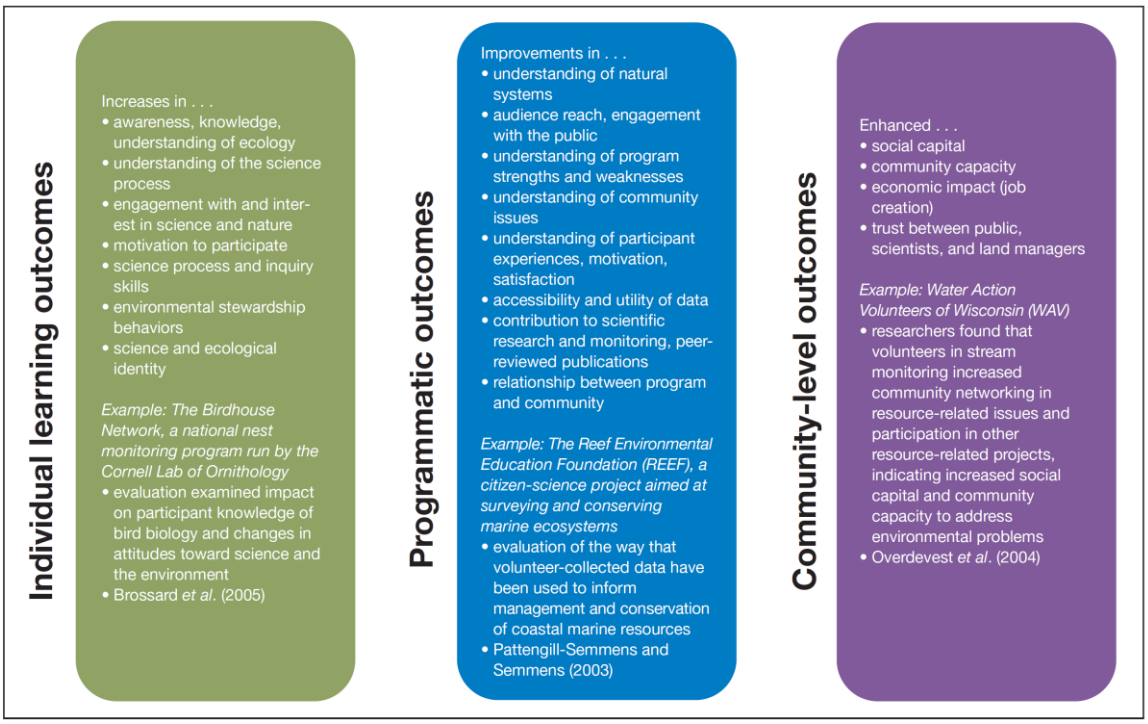


Figure: Framework for evaluation of citizen-science programs - Jordan et al. (2012)

Next steps for Citizen Science

- In this short paper that was published in the Policy Forum of the Science journal, a distinction is made between the scientific impacts of Citizen Science projects and their wider societal and environmental impacts.

Diversity of Citizen Science

- The focus of this paper is not on impact assessment of Citizen Science projects and its main purpose is to clarify and acknowledge the diversity of Citizen Science projects. Nevertheless, it highlights that while practitioners are in agreement that demonstrating impacts and benefits of CS projects is needed, standardised evaluation criteria that can be applied across all projects are difficult to find. Therefore there is a need to flexible impact assessment criteria and strategies that can be adapted to a large number of projects. This publication distinguishes between Citizen Science projects that try to answer a scientific question and those that aim for intervention in socio-ecological systems.

Measures of Success

- The evaluation tool Measures of Success (MoS) (Chandler et al., 2017) is intended to assess scientific and management outcomes across a portfolio of citizen-science projects supported by Earthwatch USA. The method is bases on the logic model and is used for reporting purposes both internal for Earthwatch staff and external for funders. Five categories (MoS 1-5) and 12

subcategories of impact are proposed. The paper includes the results of application of the tool to conduct a meta-analysis of 51 Earthwatch projects over a 7-year period.

Appendix A. Earthwatch Measures of Success (MoS)

MoS 1. Increasing scientific knowledge to facilitate and disseminate world class scientific field research

- MoS 1.1 Number of people and number of person hours dedicated to collecting scientific data
- MoS 1.2 Peer reviewed publications
- MoS 1.3 Popular publications and outreach events

MoS. 2. Engaging people in transformational learning experiences that promote environmentally sustainable action

- MoS 2.1 Education: individuals engaged and developed increased capacity

MoS 3. Enabling organizations and business to become more sustainable

- MoS 3.1 Partnerships: organizations actively engaged

MoS 4. Informing environmental policies, agendas, management plans and government policies

- MoS 4.1 Contributions to conventions, agendas, policies, and management plans
- MoS 4.2 Pro-environment actions taken at the research project site

MoS 5. Enhancing natural and socio-cultural capital to create a sustainable environment

- MoS 5.1 Taxa of conservation significance enhanced
- MoS 5.2 Natural habitats enhanced
- MoS 5.3 Ecosystem services enhanced
- MoS 5.4 Cultural heritage components enhanced
- MoS 5.5 Livelihood assets enhanced

Figure Earthwatch Measures of Success (MoS)

Community-level Indicators

- The Community-level indicators approach presented by Woods, Hemment and Bui (2015) is an example from the citizen science field of a broader approach in other disciplines (e.g. sociology, media) which use indicators at community level for triggering and monitoring social change via reporting on goal setting, progress and impact of a campaign or pilot. Woods et al. (2015) define community level indicators as 'objective measures of outcomes that reflect the concern of a specific community' (p.16), stress the collective (community) level as opposed to individual observations and argue they should be relevant, usable in practice, statistically measurable,

logically or scientifically defensible, reliable, and policy-relevant. Overall, the approach is designed to create a baseline for change, document progress towards community goals and construct meaning around findings (Woods et al., 2015). CLI are proposed for use in community assessment (identify community issues and problems; informing about campaign effects on the community themselves); accountability (metrics to track throughout course of campaign); evaluation (measure progress against campaign goals); and policy change (identify need for policy change or whether change has affected policy). The CLI approach distinguishes distinct phases (timelines) of a citizen science activity, namely goals, process, outcomes and futures and provides guiding questions to identify CLI for each phase. The underlying framing of change is based on the logical model which is accompanied by indicators for each component of the logic model (i.e. for activities, inputs, outputs, outcomes and impacts). A further distinction is made between internal and external indicators, referring to observable social changes within the community and among community members and to observable changes outside of the community of interest.

Outcomes of Citizen Science initiatives

- Based on a review of literature on impact assessment of Citizen Science projects, Kieslinger et al. (2017, 2018) propose three categories (and nine sub-categories) of outcomes of Citizen Science initiatives; social, scientific, and socio-ecological/economic. A number of evaluation criteria and supporting questions are provided to help with conducting impact assessment for different purposes. For example for internal and external, as well as mid-term and final project evaluation purposes by different stakeholder groups and actors (including funders, scientific organizations, Citizen Science projects or civil society organizations).

	Process & Feasibility	**Outcome & Impact**
Scientific dimension	• Scientific objectives • Data & systems • Evaluation & adaptation • Cooperation & synergies	• Scientific knowledge & publications • New research fields & structures • New knowledge resources
Citizen scientist dimension	• Target group alignment • Degree of involvement • Facilitation & communication • Collaboration & synergies	• Knowledge & attitudes • Behavior & ownership • Motivation & engagement
Socio-ecological/economic dimension	• Target group alignment • Active involvement • Collaboration & synergies	• Societal impact • Ecological impact • Wider innovation potential

Figure: Dimensions and main categories of the citizen science evaluation framework - Kieslinger et al. (2017)

Science products of Citizen Science projects

- Wiggins et al. (2018) propose to distinguish between four different types of science products for Citizen Science projects, namely, 'data', 'communication', 'management and policy' and 'written' products. This publication does not use a logic model and does not distinguish between outputs, outcomes and impacts of Citizen Science projects. For example produced data packages and the regulatory actions that are taken based on the produced data are both categorized as 'products', while the earlier is a direct product of an initiative and the latter is an outcome or impact of the initiative.

Table 3. Science products.

Category	Product	Definition
Written	Dissertations, theses (#)	Number of theses and dissertations using data from or reporting on the project
Written	Scholarly publications (#)	Number of published peer-reviewed science papers that report on the project or apply its data
Written	Reports (#)	Number of formal reports reporting results, such as white papers, technical, and other reports
Written	Grants awarded (#, $)	Existence (or total monetary value) of competitive funding awards from private or public funders
Data	APIs (Y/N)	Existence of technologies for automated data exchange between computers
Data	Data packages (#)	Number of curated exports of data and related documentation, usually as a downloadable zip file
Data	Metadata (Y/N)	Existence of documentation describing data structure, formats, and contents
Data	Visualizations (Y/N)	Existence of visual representations of data, such as graphs, maps, and animations
Data	Specimens/samples (#)	Number of material data points in the form of physical specimens or samples
Data	Requests (# requests, transfer volume)	Number of individuals or technical systems requesting data, or volume of transferred data
Management and Policy	Regulatory action (Y/N)	Existence of legal rulings or regulation enforcement based on project data and findings
Management and Policy	Decision support (Y/N)	Existence of decisions based on project data and findings (e.g., for policy or management)
Management and Policy	Forecasting/models (Y/N)	Existence of models based on project data that simulate or predict complex phenomena
Communication	Blogs (Y/N)	Existence of online informal written communications about project processes and findings
Communication	Newsletters (Y/N)	Existence of structured publications for project stakeholders, produced in hard copy or digitally
Communication	Videos (Y/N)	Existence of publicly available digital videos on project content, activities, and findings
Communication	Presentations (Y/N)	Existence (or number) of oral presentations at conferences or public events
Communication	Website (Y/N)	Existence of dedicated website for the project

Figure: Categories science products of Citizen Science projects - 12. Wiggins et al. (2018)

CPI framework

- Based on an extensive literature review, Gharesifard et al. (2019a) proposes a framework called the CPI (Context, Process, Impacts) framework for evaluating the establishment process, functioning and results of community-based monitoring initiatives (CBMs). The CPI framework has five different dimensions, consisting of 22 internal and context-related factors. The results dimension of this framework distinguishes between outputs, outcomes and impacts of CS initiatives and introduces six meta-categories of results. These six categories are Individual, Societal, Scientific, Economic, Environmental, and Governance-related results. Gharesifard et al. (2019b) is an example of practical application of the CPI framework for conducting a baseline analysis of two community-based monitoring initiatives in the context of the Ground Truth 2.0 project.

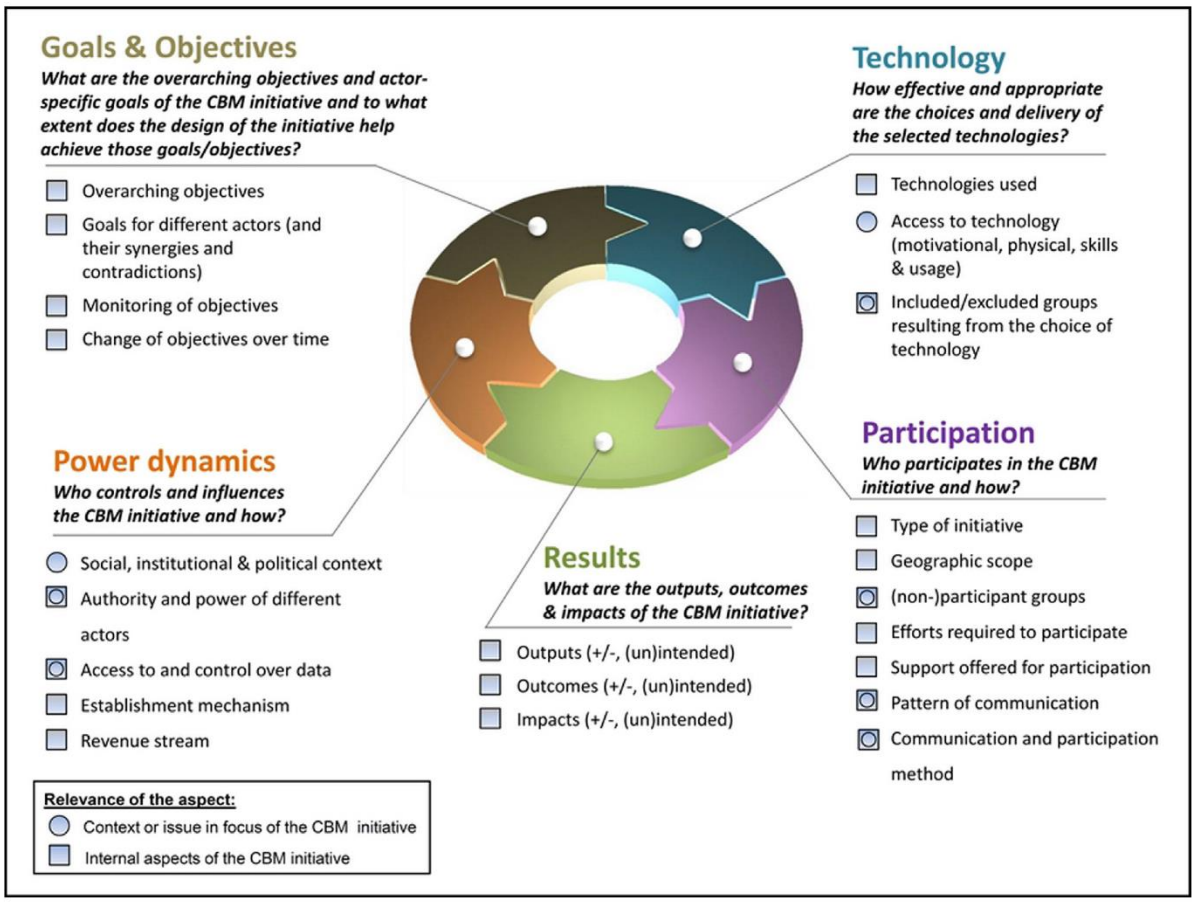


Figure: The CPI Framework - Gharesifard et al. (2019a)

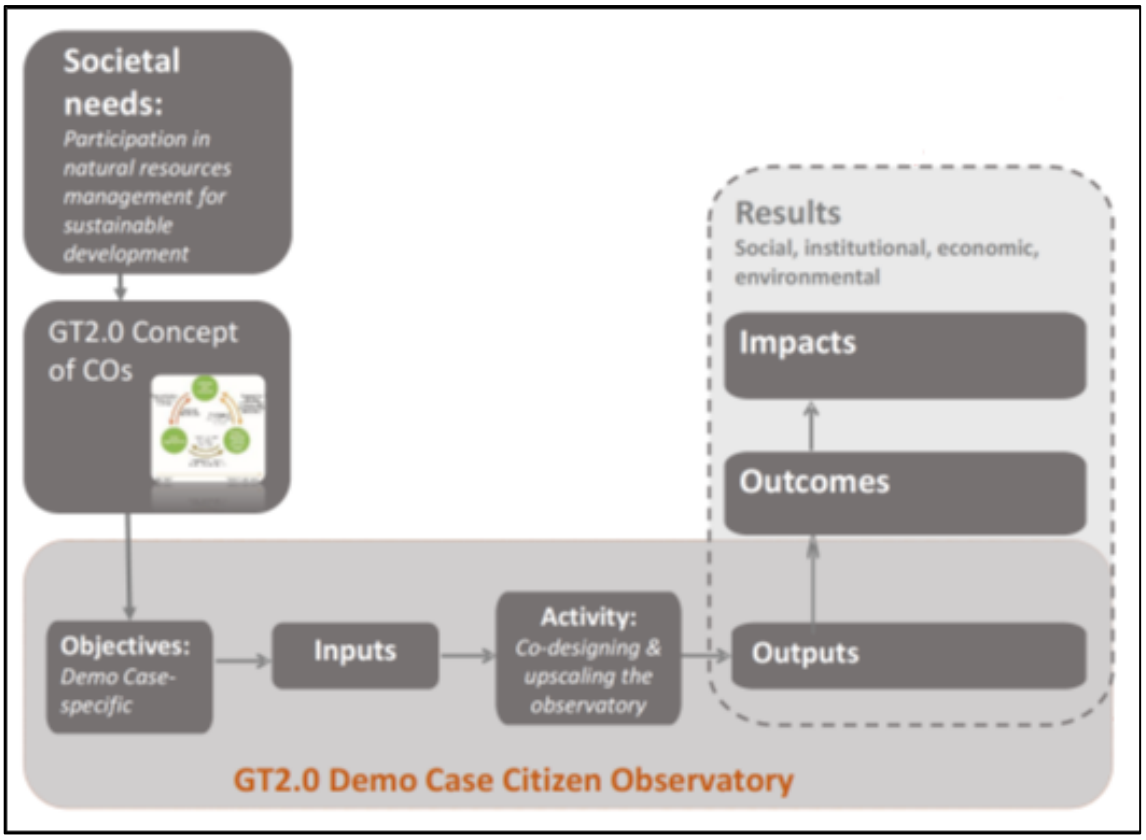
Table 2
Meta-categories of results and examples of outputs, outcomes and impacts of CBM initiatives (Source: authors).

Meta-categories of CBM results	Example of outputs	Examples of outcomes and impacts
Individual	• Publicly accessible water or environment-related databases/ datasets • Improved individual knowledge or understanding of an environmental issue • Networks of like-minded people • Development of new skill	• Improved sense of place and/or stewardship • Improved relationship between science, society and authorities
Scientific	• Datasets and information about a topic of interest • Scientific publications	• Advancement in scientific understandings about a topic • Improved relationship between science, society and authorities
Societal	• Publicly accessible water or environment-related databases/ datasets • Improved average level of knowledge or understanding of an environmental issue	• Increased social capital • Improved average level of health within society • Improved livelihoods • Improved relationship between science, society and authorities
Economic	• Immediate value of newly produced datasets (e.g. for scientists or authorities) • Creation of new jobs	• Reduced costs of resource monitoring and management • Long-term economic return of the initiative's products and services
Environmental	• Improved knowledge or understanding of an environmental issue • Higher level of awareness about, and responsibility for protection of natural resources	• Improved protection of natural resources • Improved status quo of water resources or the environment
Governance	• New channels of communication between decision makers, scientists and citizens • Additional information about environmental and natural resources	• Better-informed water or environment-related decisions & policy • Change in legislations or processes of decision making about natural resources management • Change in balance of power in decision making processes

Figure: Meta-categories of results and examples of outputs, outcomes and impacts of CBM initiatives - Gharesifard et al. (2019a)

Ground Truth 2.0 Impact Assessment framework & methodology

- The impact assessment framework developed and applied by the Ground Truth 2.0 project Wehn et al. (2017) and Wehn et al. (2020) was designed to capture the social (individual and collective), economic, environmental and institutional changes triggered by the development, implementation and upscaling of the citizen observatories that were developed by the project in four European and two African countries. This comprehensive framework (with four domains, seven sub-domains and 40 indicators) uses a results-based approach that was combined with relevant theoretical conceptualisations in order to be able to capture the particular social and institutional changes linked to the implementation of citizen observatories.



- Figure: the Ground Truth 2.0 Impact Assessment framework (conceptual view)
- Source: When et al. (2017)

- Social impacts are defined as those changes that affect the individual person (e.g. individual citizens) in terms of their perceived trust, privacy, well-being, etc. as well as communities and their resilience. Economic impacts constitute the costs and benefits of implementing the Ground Truth 2.0 citizen observatories using the Ground Truth 2.0 approach. Institutional impacts consist of changes to the formal/informal arrangements ('the rules of the game') that shape the behaviour of different actors and define how decisions are being made within a community or society at large. Environmental impacts refer to changes in the specific natural resource(s) quality or quantity that the respective GT2.0 citizen observatories focus on. Overall,

changes are conceived to be expected as well as unexpected, desirable or adverse, vary in space and time, and cumulative versus counterbalancing.

- At conceptual level, the Ground Truth 2.0 impact assessment framework stipulates that envisaged environmental changes cannot be expected to come about by the mere existence of a citizen observatory; rather, they are conditional on social and institutional changes, i.e. changes in individual and collective behaviour, policies and/or procedures related to managing the respective natural resource(s). The subsequent analyses of emerging impacts in the Ground Truth 2.0 citizen observatories showed that the extent to which the respective citizen observatories had contributed to changes in individual and collective behaviour and changes in policy and/or procedures related to managing the respective natural resource(s) are i) highly case-specific; ii) that the required policy-related changes can range from demanding entirely new policies, to clarifying the many links of the CO issue in the policy landscape, to identifying the need for additional plans or guidelines to ensure sound implementation of existing policy, to physically enabling participation mechanisms prescribed in laws but prevented by poverty; and iii) what progress had been made in each of the six Demo Cases, albeit to differing degrees, with achieving the respective social and institutional outcomes that are necessary in each case in order to, eventually, attain the envisioned environmental impacts.