Ref. Ares(2024)3174244 - 30/04/2024

BLUEMISSION AA

Building a coordination hub to support the mission implementation in the Atlantic and Arctic Basin

Holistic RRI, SDG, Open Science and Social Impact evaluation framework

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement number 101093962.

Document Information

Project Name	BlueMissionAA – Building a coordination hub to support the Mission implementation in the Atlantic and Arctic Basin
Grant Number	101093962
Deliverable number	5.8
Deliverable title	Holistic RRI, SDG, Open Science and Social Impact evaluation framework
WP number	5
Deliverable due date	31.03.2024, extended to 30.04.2024
Submission date	30.04.2024
Dissemination levels	PU (Public)
Lead beneficiary	Fraunhofer (IRB)
Author(s)	Barbara Klobucaric, Anna Baumgärtner, Dr. Hannah Keding
Contributors	T5.3 contributors: IPMA, PLOCAN, NIVA, SPI, UCC
Internal reviewers	N/A

Document history and changes

Version	Date	Author	Description
0.1	15.04.2024	Barbara Klobucaric, Anna Baumgärtner, Hannah Keding	First draft
0.2	23.04.2024	Joelina Delphin, André Valente, Valerie de Liedekerke de Pailhe	Comments and edits
1	30.04.2024	Barbara Klobucaric, Anna Baumgärtner, Hannah Keding	Final version

Authors | Barbara Klobucaric, Anna Baumgärtner, Hannah Keding

Publisher | BlueMissionAA Project Consortium

How to cite | 2024. *BLUEMISSIONAA Deliverable 5.8.* Holistic RRI, SDG, Open Science and Social Impact evaluation framework. 37 pp.

Supported by/In partnership with

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Glossary

Acronym	Meaning
AREA	Anticipate, reflect, engage, act (process dimensions of RRI) (ORBIT RRI, 2023)
EPSCR	The Engineering and Physical Sciences Research Council
EU	European Union
EU Mission	EU Mission 'Restore our Oceans and Waters by 2030'
Fraunhofer IRB	Fraunhofer Information Center for Regional Planning and Building Construction
IPMA	International Project Management Association
NIVA	Norwegian Institute for Water Research
PLOCAN	Plataforma Oceánica de Canarias
R&I	Research and innovation
RRI	Responsible Research and Innovation
RSSR	UNESCO Recommendation on Science and Scientific Researchers
SDGs	Sustainable Development Goals
SPI	Sociedade Portuguesa de Inovação
UCC	University College Cork
UN	United Nations

UNESCO	United Nations Educational, Scientific and Cultural Organization
WP	Work package

1 Summary

Responsible Research and Innovation (RRI), Sustainable Development Goals (SDGs), Open Science and Social Impact pursue a similar aim. All these established guidelines are dedicated to aligning research, innovations and products with societal and environmental needs. Therefore, they are very important in every research and innovation, especially when a lot of people are affected as in coastal restoration. It is thus necessary that we make these values practically applicable for every research and innovation project.

Our holistic evaluation framework supports this objective, as it unites the before mentioned aspects within a common structure and reduces complexity. It facilitates a maturity assessment identifying the extent to which projects within the EU Mission 'Restore our Oceans and Waters by 2030' utilise their sphere of influence to uphold ethical standards and address societal and planetary needs. The initial version of the framework is presented in section 7 and will be updated in Deliverable 5.9 at a later stage.

An important motivation for the evaluation framework is knowledge transfer. It holistically demonstrates the manifold possibilities of a project to have a positive societal and ecological influence on three levels: the motivational, the process and the outcome level. By reflecting on its questions, users of the framework can realise positive effects and further potential of their project, as well as areas of development and conflict. That way one cannot merely evaluate projects, but rather investigate them. The framework should offer helpful perspectives, spark discussion and iterative improvement than be understood as a singular point-scoring exercise.

2 Introduction

BlueMissionAA promotes the European Union's (EU) Mission 'Restore our Oceans and Waters by 2030' (European Commission, 2024a) in the Atlantic and Arctic basins by building a coordination hub. This EU Mission aims to protect and restore our oceans and waters by the means of research and innovation, citizen engagement and blue investments. It also has a pivotal role in achieving climate neutrality. With four area-based 'Mission lighthouses', i.e. Atlantic-Arctic, Mediterranean Sea, Baltic-North Sea, and Danube-Black Sea, the EU Mission encompasses places to pilot and showcase, develop and apply the Mission activities (European Commission, 2024a). BlueMissionAA's focus is on preserving and restoring marine and coastal ecosystems and biodiversity to improve climate resilience (BlueMissionAA, n.d.).

2.1 Task 5.3: Holistic RRI, SDG, Open Science and Social Impact evaluation framework

Within BlueMissionAA, we are developing a holistic evaluation framework that incorporates aspects of Responsible Research and Innovation (RRI), the United Nation's (UN) Sustainable Development Goals (SDGs), Open Science, and Social Impact throughout the entire value chain. We from Fraunhofer IRB (Fraunhofer Information Center for Regional Planning and

Building Construction) are leading the Task on this (T5.3) which is part of work package 5, Citizen Engagement & Knowledge Transfer. The BlueMissionAA Grant Agreement (European Climate, Infrastructure and Environment Executive Agency (CINEA), 2022, p. 84) specifies Task 5.3 as follows:

> "Sustainability, responsibility and ethics are the cornerstones of all current research, development and innovation. This is particularly important in the area of coastal restoration, because so many citizens are affected. To ensure that the solutions and processes developed are compliant with current standards, frameworks are needed for an analysis and assessment in this regard. Hence, this task will compile a holistic evaluation framework to measure responsibility, sustainability, knowledge transfer, social impact and ethics [...] that includes the following aspects: (a) Responsible Research and Innovation (RRI) evaluation framework for innovation processes; (b) Sustainable Development Goals (SDG) evaluation framework for systems, product and solutions; (c) Social Impact evaluation framework for the whole value chain: Input and results from WP1 (D5.8)."

To archieve this task, we researched the elements of the holistic framework and how far according evaluation frameworks already existed. During this process, we discussed with multiple BlueMissionAA partners including, IPMA, PLOCAN, NIVA, SPI and UCC, the ways in which such an evaluation framework would be useful and well-applicable for projects within the EU Mission and beyond, to also create a lasting benefit. Taking all of this into account, we set the aim of our framework, as described forthfollowing.

2.2 Aim

The overarching aim of our framework is to provide added value to projects by increasing their knowledge of and helping them comply with current EU, UN and other standards for responsible research and innovation, as well as Sustainable Development Goals. Based on this framework, we created an assessment tool in the form of a questionnaire that facilitates self-reflection on the alignment of projects with the principles of responsibility, sustainability, knowledge transfer, Social Impact, and ethics, as well as potential trade-offs between outcomes.

Using our self-evaluation framework early on in a research and innovation project, or in its planning phase, helps to address relevant questions of responsibility, sustainability and ethics without researching them all on one's own or going through very detailed and time-consuming distinct assessment tools for each of the dimensions – which are also partly not designed for the project level. Based on our self-evaluation framework, adjustments to better take into account responsibility, sustainability and ethics can be made at the beginning or at any stage of the research process. Our aim is to support such a continuous reflection, improvement and thus learning in relation to those dimensions than to only provide ratings at the end of a project – where adjustments are no longer possible. However, our framework also enables such ratings which are of course subjective self-ratings and can be influenced by biases in relation to self-perception.

To increase the awareness and adherence to sustainability, responsibility, and ethics within coastal restoration, we not only aimed to develop a holistic evaluation framework, but to also help projects within the EU Mission 'Restore our Oceans and Waters by 2030' to apply it; and to use their feedback and experiences to improve the framework for future use, e.g. within other EU projects. We firstly plan, as outlined in the Grant Agreement of BlueMissionAA (European Climate, Infrastructure and Environment Executive Agency (CINEA), 2022, p. 13f), to help our partners in Work Package 5 (Citizen Engagement and Knowledge Transfer) apply the holistic evaluation framework (a) in their mutual engagement activities with citizens, including civil society, researchers, indigenous and local communities, and local businesses and (b) in their knowledge transfer to relevant stakeholders with the measurable evaluation factors which our framework provides. We might also help other projects in the EU Mission 'Restore our Oceans and Waters by 2030' apply the holistic evaluation framework, potentially the six case studies selected as part of Milestone 3.2 within BlueMissionAA. We selected these, because those larger research and innovation projects will be better equipped resource-wise to apply the framework and to address more of its aspects than smaller projects – making an application more likely and effective. However, any application will happen at a later stage of the project, documented in Deliverable 5.9, which represents an update of Deliverable 5.8.

Relating to the focus of the EU's Missions, our framework is designed primarily for research and innovation projects. Through the framework's structure in terms of purpose, process and outcome, it is usable for the various applications listed in BlueMissionAA's Grant Agreement, i.e. processes, systems, products and solutions (European Climate, Infrastructure and Environment Executive Agency (CINEA), 2022, p. 84).

Following this introduction, we first describe the distinct dimensions of the holistic evaluation framework, i.e. RRI, SDGs, Open Science and Social Impact in section 3. We then characterise how we merged these four dimensions into a coherent framework and how we structured it (section 4). Section 5 will provide a detailed description of our methodology, i.e. how and why we designed the framework in terms of its distinct items and reflection questions. Our aim hereby is to adhere to good research practices ourselves and thus to describe our own research process as transparently as possible. In section 6, we discuss limitations of our approach and give an outlook on how we plan to proceed with the framework. Finally in section 7, we display the holistic RRI, SDG, Open Science and Social Impact evaluation framework which we developed. The artificial intelligence tools Elicit (2023) and FhGenie (2024) supported the literature research and the linguistic style and corrections of this report.

3 Concepts of the framework

In the following sections, we introduce the distinct concepts that are part of our holistic evaluation framework: SDGs, RRI, Social Impact and Open Science.

3.1 Sustainable Development Goals (SDGs)

The Sustainable Development Goals (SDGs) are part of the 2030 Agenda, which is a global action plan for sustainable development. They were agreed on by all governments and

adopted by the United Nations in 2015 (Diniz et al., 2023). Put simply, they are an action plan "for people, planet and prosperity" (United Nations, n.d.b).

The motivation behind the goals emerged from a shared desire expressed at the Rio+20 Nations Summit in 2012. This desire was to establish a set of guidelines that would support developing countries, poorer populations, and promote environmental sustainability (Caiado et al., 2018). While all the goals address societal needs (Jensen et al., 2021, p. 96), each of them focuses on distinct thematic aspects, such as water, energy, climate, oceans, urbanisation, transport, science and technology (ibid.). All 17 Sustainable Development Goals, their assigned 169 targets and 231 indicators are described in detail on the website of the United Nations (United Nations, n.d.a). Figure 1 gives an overview over the 17 Sustainable Development Goals.

Figure 1: Sustainble Development Goals (United Nations, n.d.a)

Even though the SDGs result from an agreement between governments, effort from all societal actors is explicitly demanded to implement the goals (Mansell, Philbin and Konstantinou, 2020). Consequently, they are also relevant for research and innovation projects. One purpose of our framework is to support the implementation of the SDGs at the project level, specifically of

research and innovation projects within the EU Mission 'Restore our Oceans and Waters by 2030'. Therefore, we address the relevant challenge stated by Mansell et al. (2020, p. 5): "How can the targets and indicators that were designed for national and global level reporting be cascaded down to project level?". The framework also helps raising awareness about the SDGs and their significance for research and innovation, as survey findings (Tash and Jansen, 2021, p. 81) indicate that research is often not centered around the ideas and concepts of the SDGs ibid. (2021).

3.2 Responsible Research and Innovation (RRI)

The concept of Responsible Research and Innovation (RRI) was officially introduced by the European Union through its research and innovation funding programme, Horizon 2020, which was active from 2014 to 2020. The idea behind RRI arose collaboratively by technology researchers, politicians and corporations (RRI Tools Konsortium, n. d.). RRI's main objective is to ensure that research and innovation, including their processes and outcomes, align with societal values and needs (RRING Project, n.d.). A crucial element of RRI is the active engagement of various stakeholders in research and innovation processes (ibid.). This promotes shared responsibility among researchers, policymakers, civil society organizations, business actors and members of the education community (RRI Tools Konsortium, n. d.). Its participatory nature along with RRI's umbrella function of integrating various guidelines related to governance and codes of conduct are the main characteristics of RRI (ibid.).

For the operationalisation of RRI, the European Union developed the six keys of RRI: Ethics, Science Education, Gender Equality, Open Access, Governance, and Public Engagement. They answer the question of 'what' to do in research and innovation projects to ensure RRI (ORBIT, 2023). Moreover, the Engineering and Physical Sciences Research Council (EPSCR) developed the AREA 4P Framework for RRI (ORBIT RRI, 2023) that answers the question of 'how' to do RRI. It is based on the following principles: Anticipate, Reflect, Engage and Act.

3.3 SDGs and RRI

While the SDGs can be defined as meta guidelines for sustainable development on the global level which is relevant for every societal aspect, RRI is specifically directed towards research and innovation. Nonetheless, the overarching goals are similar. According to Wender et al. (2014), the objectives of RRI are "guiding innovation toward beneficial social and environmental outcomes". The definition by Lindner et al. (2016) is even more encompassing, as on top of ecological and social challenges, RRI should also address economic ones. Here, the similarity in objectives between the SDGs, which encompass "economic, social and environmental" (United Nations, n.d.b) dimensions, and RRI becomes evident.

The nature of the SDGs as a meta framework suggests that RRI should actively contribute to their achievement (RRING Project, 2020). Consequently, a research question within our task is: How can RRI evaluations be enhanced to better consider the contribution of a project to the SDGs? By advancing RRI with SDGs, projects could enhance their capacity to solve the urgent "Grand Challenges globally" (Bundesumweltministerium, n.d.; RRing Project Consortium, 2021)

(RRing Project Consortium, 2021), which are "societally-relevant issues that require creativity and transdisciplinary collaboration" (Boise State University, 2024).

Consequently, the SDGs provide for RRI a global perspective with concrete objectives to work towards. RRI in turn plays a crucial role in ensuring the responsible and ethically robust realisation of the SDGs (Rosemann and Kgwadi, 2020). Therefore, the process leading to the achievement of objectives needs to be evaluated. It is insufficient to solely assess the planned or achieved contributions of research and innovation to the SDGs. Proper RRI practices, including anticipation and reflection processes, are necessary to mitigate risks of trade-offs in SDG impacts (2020, p. 27). That is why, in our framework, we emphasise the research process besides project outcomes (cf. section 5).

To create a holistic framework that encompasses all relevant processes and outcomes of research and innovation in relation to societal needs, it is useful to include aspects of Social Impact along the entire value chain and of Open Science. With these, we complement SDGs and RRI as the main concepts of our framework.

3.4 Social Impact

Social Impact describes all changes and effects people and communities experience due to the whole life cycle of a project. "Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment" (Vanclay, 2003, p. 5). Every step and every phase of a project is important, and every change related to the project counts. Social Impact is not necessarily a direct result or outcome of a project. It can be direct and indirect – it covers all changes affecting people caused by the process or the outcomes of a project. Accordingly, all social consequences are relevant: intended and unintended, positive and negative (ibid.).

Everything that affects people can be part of Social Impact. Consequently, Social Impact is very broad and relates to many other fields of assessment, e.g. health care or cultural impact (ibid.). Vanclay (2003) conceptualises Social Impact as a change of one or more of the following aspects:

- "people's way of life – that is, how they live, work, play and interact with one another on a day-to-day basis;
- their culture – that is, their shared beliefs, customs, values and language or dialect;
- their community – its cohesion, stability, character, services and facilities
- their political systems [...];
- their environment – the quality of the air and water people use; the availability and quality of the food they eat; the level of hazard or risk, dust and noise they are exposed to; the adequacy of sanitation, their physical safety, and their access to and control over resources;
- their health and wellbeing [...];
- their personal and property rights - particularly whether people are economically affected, or experience personal disadvantage which may include a violation of their civil liberties;

- their fears and aspirations – their perceptions about their safety, their fears about the future of their community, and their aspirations for their future and the future of their children" (Vanclay, 2003, p. 8).

While Social Impact addresses the concrete impact of actions in the social sphere, the SDGs are a broader, overarching framework for interdependent goals in the social, ecological and economic spheres on a global scale. It is useful to include Social Impact into the evaluation framework because it provides a deeper understanding of how a project with its processes and outcomes directly or indirectly affects individuals and communities.

3.5 Open Science

The United Nations Educational, Scientific and Cultural Organization (UNESCO, 2021, p. 7) defines Open Science as

> "[...] an inclusive construct that combines various movements and practices aiming to make multilingual scientific knowledge openly available, accessible and reusable for everyone, to increase scientific collaborations and sharing of information for the benefits of science and society, and to open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community."

This definition is part of UNESCO's Recommendation on Open Science which has been the first to establish an internationally agreed standard on Open Science (UNESCO, 2023) and is accordingly relevant. The Recommendation also provides shared values, guiding principles and actions for a fair and equitable operationalisation of Open Science (UNESCO, 2021). These can guide a very in-depth application of Open Science in research processes – more so than the framework at hand could provide.

Previously, Vicente-Saez and Martinez-Fuentes (2018) found that several studies agreed that there was a lack of awareness about the meaning of Open Science – mainly because there was no formal definition of it. Fecher and Friesike (2013) clarified the plurality of understandings of Open Science by reviewing the literature and structuring it into five Open Science schools of thought. These can be differentiated by varying assumptions about the future of knowledge creation and dissemination and foci in relation to the phases of research and the media to establish its openness. The authors carve out:

- "The *infrastructure school* (which is concerned with the technological architecture),
- the *public school* (which is concerned with the accessibility of knowledge creation),
- the *measurement school* (which is concerned with alternative impact measurement),
- the *democratic school* (which is concerned with access to knowledge) and
- the *pragmatic school* (which is concerned with collaborative research) (Fecher and Friesike, 2013, p. 0, emphasis in original).

UNESCO's Recommendation on Open Science (UNESCO, 2021) specifies the concept's key pillars and subaspects which we list here for a better understanding – for more detail, see UNESCO (2021):

- Open scientific knowledge:
  - Scientific publications
  - Open research data
  - Open educational resources
  - Open source software and source code
  - Open hardware
- Open science infrastructures:
  - Virtual
  - Physical
- Open engagement of societal actors:
  - Crowdfunding
  - Crowdsourcing
  - Scientific volunteering
  - Citizen and participatory science
- Open dialogue with other knowledge systems:
  - Indigenous peoples
  - Marginalised scholars
  - Local communities

While there is significant overlap between RRI and Open Science, their emphasis differs and it is therefore useful to separately integrate Open Science into our framework. While RRI focuses on normative concerns and democracy deficits ("science for and with society", Garfinkel (2020, p. 99)), Open Science emphasises efficiency and technical optimisation (Shelley-Egan, Gjefsen and Nydal, 2020) in the research process and in the disposition of findings (Garfinkel, 2020, p. 99). With this focus, Open Science depends on a "trade-off between disclosure and secrecy" (Mukherjee and Stern, 2009, p. 449), operating under the principle "as open as possible, as closed as necessary". This means that findings and data may not be made publicly accessible if it is against the researcher's legitimate interests, e.g. commercial exploitation of research or obligations through their funding (European Commission, 2024b).

3.6 Merging the four concepts

The objective of the holistic evaluation framework is to integrate these four previously described concepts. Their discussion illustrates notable similarities among them. Their overarching commonality is that they all address societal needs. However, the similarities could give rise to questions and confusion when evaluating a project. For instance, it might be unclear whether Social Impact should be assessed independently from the impact on the SDGs. Also, there may be uncertainty about whether an SDG assessment is necessary when RRI already encompasses ecological, economic, and social values. Herein, it is important to recognise that the distinct concepts of the framework differ in terms of perspectives and levels. One objective in developing the framework is to identify the concepts' overlaps, align their aspects within a unified perspective where feasible, and otherwise, establish a structure that allows for the coexistence of differing perspectives.

For instance, the SDGs address all societal fields on a global scale, while Open Science is particularly relevant in the field of research. Moreover, RRI dimensions address the process level

while SDGs are concerned with projects' impact. Thus, our task contemplated the creation of a single framework that accommodates all of these diverse perspectives and levels to help EU Mission projects answering the following question:

> *To which degree does my research and innovation project in the field of ocean and water restoration use its total sphere of influence to address societal and planetary needs?*

The subsequent section presents the outcomes of this endeavour.

4 How the framework works

4.1 Framework structure

In this section, we explain the holistic evaluation framework tailored to research and innovation projects within the EU Mission 'Restore our Oceans and Waters by 2030'. It combines aspects of RRI, SDGs, Open Science and social Impact of the whole value chain.

A primary focus of the framework is its future applicability. It facilitates a maturity assessment identifying the extent to which EU Mission projects utilise their sphere of influence to uphold ethical standards and address societal and planetary needs. The evaluation framework holistically demonstrates the manifold possibilities of a project to have a positive societal and ecological influence on three levels: the motivational, the process and the outcome level. The framework includes assessment questions that promote self-reflection throughout the research process rather than solely checking once for specific indicators. This approach encourages projects to adapt their strategies throughout their work – which is particularly important for innovations since they might have unintended consequences.

It facilitates a maturity assessment identifying the extent to which projects within the EU Mission 'Restore our Oceans and Waters by 2030' utilise their sphere of influence to uphold ethical standards and address societal and planetary needs.

The framework structure we employ is based on Stahl et al.'s (2017) RRI maturity model and its three categories: Purpose, Process, and Product. This structure is suitable because it makes the distinct evaluation levels visible, as some criteria assess the process whilst others focus on the outcomes. Here we explain the three categories, along with their respective criteria:

1. Purpose: This category refers to the underlying reasons for undertaking the research and innovation endeavour (Stahl et al., 2017, p. 4). We have included two criteria in this category, adapted from Stahl et al.'s original framework (ibid.). The first is ‚Motivation behind your project', which concerns the motivation for meeting societal and planetary needs as a main motivation for a project rather than others, such as financial or career objectives. Hereby, motivation concerns the outcomes or products of a project. The second criterion is 'Motivation for engaging with RRI'. Since our framework places emphasis on the process level, a high maturity level would signify that Responsible Research and Innovation practices are pursued out of conviction rather than out of external pressures.

2. Process: This category is about all activities that are part of a research and innovation project (ibid.). In section 3.3, we explain the importance of assessing the process level. The Process category encompasses the RRI dimensions Anticipation, Reflection and Engagement of the AREA framework, as they "suggest processes that should be incorporated into R&I endeavours" (Stahl et al., 2017, p. 5). The dimension 'Action' of the AREA framework, which is about taking concrete steps to implement RRI, is incorporated into the other three dimensions. The Process category also contains the RRI process-related keys Research Ethics and Governance and just one SDG that overlaps with Engagement: SDG 17, Partnerships for the Goals (Bundesumweltministerium, n.d.). Overall, we have incorporated all RRI criteria of the original framework by Stahl et al. (2017). However, in the criteria names we highlighted the connection of Engagement with SDG 17 and the connection of Anticipation with Social Impact.

3. Product: This category is about the tangible outcomes, the actual consequences and the impact of a research and innovation project (Stahl et al., 2017). Accordingly, the criteria include Social Impact, SDGs and corresponding RRI keys. Here, all the RRI keys which are not part of the process-level are assigned to: Gender Equality and Diversity, Science Education, and Open Science – which we adapted from Open Access in the original framework (Stahl et al., 2017). We merged Gender Equality and Diversity with SDG 5 (Gender Equality) and Science Education with SDG 4 (Quality Education). In this category, we have also included the SDGs 6 (Clean Water and Sanitation), 9 (Industry, Innovation and Infrastructure), 10 (Reduced Inequalities), 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), 13 (Climate Action), 14 (Life below Water), and 15 (Life on Land) as criteria because the EU Mission projects could have potential impacts and trade-offs concerning these SDGs. This category also places special emphasis to Social Impact as one of the four aspects by assigning it an individual criterion.

4.2 Assessment questions

Each criterion is assessed using a single broad evaluation question, such as "To what extent is public engagement part of your research process?" These questions for all criteria are uniformly structured using the format "To what extent...?" to ensure consistency. Answers to these questions are rated on a Likert scale ranging from 1 to 5, where a rating of 1 represents "to no extent" and a rating of 5 "to a great extent." We chose the Likert scale due to its simplicity and ability to capture sufficient nuances for self-reflection. This rating scale sets the foundation for developing a maturity assessment, where each level on the scale represents a different maturity level. The results of the assessment can be visualized using a radar diagram, which provides a comprehensive overview of maturity levels across different criteria. This will display possible areas for improvement.

In the framework, we have included 20 broad assessment questions, which we regard as a reasonable number to ensure that the framework is comprehensive regarding its underlying concepts without becoming overly extensive. Our goal is to maximise user-friendliness, considering that the future assessment will be designed as a voluntary questionnaire to be completed alongside daily research activities.

Since the assessment questions might be difficult to answer directly, we also provide reflection questions for assistance. The reflection questions are more specific and help understanding the criterion. For example, a question to reflect on the extent to which *Research Ethics* are incorporated into a project is: "Does your data collection require informed consent from the participants?". Table 1 shows the framework structure, section 7 the complete framework.

It is important to note that reflection questions relating to the SDGs should only be understood as suggestions and will not suit all projects. In this they differ from the remaining reflection questions, i.e. regarding RRI and others, which should be considered in all research and innovation projects.

The main objective of the framework is to facilitate knowledge transfer and self-reflection, rather than external evaluation. That way, the framework offers added value to projects by fostering a deeper understanding of SDGs, RRI, Social Impact and Open Science, as well as their interconnectedness, and to help projects assess their own positions within these aspects.

Table 1. Framework structure

Category	Question	Scale	Reflection Questions
Purpose			
Process Criterion 1 Criterion 2 ...			
Outcome Criterion 1 Criterion 2 ...			

5 How we develop the framework: methodology

In summary, for developing the framework in its current version, the following steps were carried out: 1) Research on the concepts and their operationalisation; critical reflection on existing evaluation frameworks and assessments; 2) Development of a draft version of the framework. In the following, findings and details regarding these steps are explained. Thereby, we show how our framework builds on and complements existing work.

5.1 Developing the framework structure

We began by collecting information about Responsible Research and Innovation (RRI), Sustainable Development Goals (SDGs), Social Impact and Open Science by researching how these concepts are defined and operationalised, especially at the project level. It became clear that RRI and SDGs are the two more comprehensive aspects of the four as shown in section 3. Therefore, we continued by researching existing evaluation-oriented assessments, models and frameworks regarding SDGs and RRI. This would allow to then incorporate the narrower concepts of Social Impact and Open Science within broader frameworks. To effectively build on existing work, we paid special attention to models that already combine RRI and SDGs and found the following:

Buehrer-Topcu and Roth (2023) have developed an evaluation and monitoring tool that combines RRI with the SDGs. However, there is a lack of clarity regarding its application, evaluation, and presentation of the survey results. This is because the questions are not formulated in a consistent manner. We also noted that the questionnaire with 41 questions, often with multiple sub-questions, could be too extensive for our purposes.

Therefore, our framework takes a different approach. It focuses on self-reflection and user-friendliness by employing fewer questions. Besides, all questions in our framework are structured in a consistent manner. This allows for an easy evaluation of responses using a radar diagram, based on the 5-point Likert scale. This visual representation could provide an immediate and clear overview, enabling the project to see its strengths and weaknesses. Additionally, this allows the framework to be easily transformable into a self-assessment tool, eliminating the need for an external evaluation.

Furthermore, the RRING project, funded by Horizon 2020, also focuses on exploring the relation between RRI and the SDGs. Its objective is to understand how RRI can contribute to achieving the SDGs (RRING Project, 2020). The authors propose using the UNESCO Recommendation on Science and Scientific Researchers (RSSR) "as a bridge, to link RRI and SDGs on a global scale, as it shows considerable enthusiasm globally for both the SDGs and aspects of RRI" (Rosemann and Kgwadi, 2020, p. 83). The difference between RRI and RSSR lies in their scope and backgrounds. RRI is rooted in EU policy and research, while RSSR is a global policy instrument ratified by 195 member states of UNESCO in 2017. That way, RSSR provides a structure that is globally recognised and accepted for promoting principles related to RRI (Jensen, n.d.). In our framework, we do not see the necessity to work with RSSR. However, since RRI encompasses topics that overlap with RSSR (Jensen et al., 2021), we used the work of the RRING project on the connection of RSSR with the SDGs (Rosemann and Kgwadi, 2020, p. 1) to create self-reflection questions that highlight the connection between SDGs and RRI. However, the project does not offer a concrete evaluation framework for these connections.

As we did not find a suitable evaluation framework encompassing more than one of our four concepts, we researched frameworks addressing a single concept with the intention of combining these into a holistic framework. We found Stahl et al.'s (2017) framework the most suitable to use as a foundation for our purposes (presented in section 4), as we justify forth following.

Stahl et al.'s (2017) framework was designed as an RRI maturity model, but its structure allows for the seamless integration of the SDGs, namely at the Product category. This is precisely why we opted for this framework. The Product category proved to be inherently suitable for incorporating SDGs and specific aspects of Social Impact, as the RRI criteria listed in this category, such as Gender Equality and Social Justice, simultaneously represent SDGs. Besides, Stahl et al. (2017) already aspired to extend RRI with more aspects that are not yet covered by the RRI keys or the AREA framework with criteria of "Sustainability" and "Social justice / inclusion". This serves as ideal connecting points for adding aspects of the SDGs relating to sustainability and social justice as well as aspects of Social Impact. Thereby, we could add criteria at the Product level to create a holistic framework whilst maintaining the useful structure of the RRI maturity model.

We adopted most of Stahl et al.'s (2017) criteria and their location within the categories because they are comprehensive and logically organised. Their RRI framework combines criteria of the AREA framework by the EPSCR (ORBIT RRI, 2023) as well as the six RRI keys developed by the EU Commission (cf. section 3.2) and even adds further social and environmental aspects. This laid a very fitting ground for our purpose of creating a holistic evaluation framework. As Stahl et al. (2017) discuss, the position of the RRI keys could be debated, for example placing Research Ethics under the Process and not the Product category. However, we agree with the authors that the exact positioning is only of secondary importance. More relevant is the inclusion of all relevant criteria into the framework.

5.2 Adapting the framework structure and including missing aspects

To simplify and streamline the framework, we made some adjustments. In the Purpose category, we omitted the criterion of "Ethics (intended outcomes)" (Stahl et al., 2017), as we found it to be covered by the criterion "Motivation for engaging with RRI" (ibid.), since Ethics is a RRI key. Furthermore, we changed the "Motivation for doing the research" (ibid.), to Motivation behind the Project to account for research not always being the primary focus of the EU Mission projects.

Regarding the Process category, we did not include "Responsiveness" (ibid.) as a separate criterion. We consider this aspect of RRI to be part of Governance, which encompasses "[...] hard and soft multilevel structures, guidelines and arrangements with the aim to optimize our responsivity to societal challenges, needs and concerns [...]" (RIPEET Project Consortium, 2020). Therefore, we address Responsiveness through a self-reflection question within the Governance criterion.

Subsequently, we incorporated the SDGs into the framework. While the RRI criteria are applicable to all research and innovation projects, not all SDGs hold equal relevance in every project, as indicated by the SDG Compass (GRI, UN Global Compact & WBCSD, 2015). To streamline the evaluation framework and reduce complexity, we only included the SDGs relevant in the context of the EU Mission 'Restore our Oceans and Waters by 2030'. This

approach is supported by Mansell et al.'s (2020) literature review, which suggests the need to simplify the complex nature of the 17 goals and prioritise a reduced selection for assessment.

On the one hand, we aimed to simplify the four concept's many aspects for our holistic framework, particularly concerning the SDGs. On the other hand, the framework recognises that ocean and water restoration projects bear responsibility for multiple SDGs that are not directly linked to oceans or water. This acknowledges the interconnected nature of the SDGs, which can result in co-benefits and trade-offs when attempting to achieve a single goal (Singh et al., 2017).

Therefore, the framework goes beyond evaluating the impact on SDG 14 which is "life below water" and defined by: "Conserve and sustainably use the oceans, seas and marine resources for sustainable development" (Project Everyone, n.d.). In this initial version of the framework, we have not extensively explored the literature on the connection between different SDGs and ocean and water restoration projects. However, we have identified several articles that examine the link between SDGs and the maritime industry or the blue economy (Singh et al., 2017; Said and Chuenpagdee, 2019; Lee, Noh and Khim, 2020; Diniz et al., 2023) which served as sources for orientation. We have incorporated SDGs into the framework based on their potential relevance, with the intention of refining the selection for the next Deliverable 5.9.

As previously mentioned, we substituted the original criterion "Sustainability" in the framework by Stahl et al. (2017) with various environment- and climate-related SDGs; namely the SDGs 6, 9, 11, 12, 13, 14 and 15. Each of these SDGs was added as an individual criterion.

Then, we merged existing criteria which have parallels with SDGs. The original criterion Social Justice / Inclusion also represents SDG 10. The RRI key Engagement correlates with SDG 17, and Gender Equality has a direct parallel with SDG 5 (RRing Project Consortium, 2021). Science Education aligns with SDG 4 Quality Education, so we covered it in one criterion. Even though the SDG Quality Education is broader than the RRI key, we covered them in one criterion as the impact that the research and innovation projects can have on Quality Education is mainly through Science Education. While merging, we indicated the origins of the criteria from the respective RRI keys and SDGs.

We have also organized the criteria in a manner that reflects their conceptual origins. In the Process category, the RRI dimensions are grouped together, and the RRI keys are listed consecutively. Similarly, in the Product category, criteria that combine RRI and SDGs are grouped together, while SDGs that are not directly linked to RRI keys are also grouped separately. We intend to maintain some form of labelling to indicate the origin of the criteria, which in the current framework version is in brackets after the criteria, as we continue to develop the framework. This approach aims to enhance awareness and understanding of both, SDGs and RRI principles.

At this stage, we had two of the four aspects included in the framework: RRI and the SDGs. In the next step, we incorporated Open Science and Social Impact into the framework.

We found that Open Science is partially covered by RRI, inter alia since Open Access is an RRI key and also a component of Open Science (cf. section 3). While Stahl et al.'s (2017) framework mentions Open Access, the ORBIT Self-Assessment (Stahl, 2017) (an advancement of Stahl et al.'s framework) replaces Open Access with Open Science as an RRI criterion. We equally used Open Science as a singular criterion since it includes Open Access.

Regarding Social Impact, certain elements are already addressed by the SDGs, such as Social Inequality or Clean Water and Sanitation, which are distinct criteria in the framework. However, we identified additional elements that were not fully captured by the SDG criteria in the Product category. Consequently, we created a separate criterion for Social Impact. Open Science and Social Impact as individual criteria are accommodated between RRI and SDGs, as they are connected to both concepts.

5.3 Developing the evaluation questions

As this framework enables an assessment, we added evaluation questions to the criteria. The structure of the evaluation questions is mainly inspired by the SDG Impact Assessment Tool (Eriksson, n.d.) because of its focus on self-reflection and simplicity. Here, the questions follow a consistent format which is “How does your case impact SDG ...?” (ibid.) Thus, only one broad question per SDG is to be answered. The five answer choices provided for each evaluation question, namely "Direct positive", "Indirect positive", "No impact", "Indirect negative", and "Direct negative" (ibid.), allow for a clear categorisation of a project’s impact. This enables a straightforward overview of the results, i.e. the case's impact on the SDGs. Additional information, being descriptions of the respective SDG and the connected targets, is provided to assist respondents in answering the broad question.

In our framework, we have adopted the same approach of providing one evaluation question per criterion that encourages self-reflection. These evaluation questions are also accompanied by answer choices on a 5-point Likert scale, allowing for a range of options. Besides, we also assist to answer the question with cues on what the criterion is about. This is essential to our framework as one of its objectives is transfer of knowledge. However, in contrast to the SDG Impact Assessment Tool, we have chosen not to provide extensive descriptions of the criteria in our framework. Instead, we have opted to include reflection questions that respondents can answer for themselves. They help to get an orientation about what relevant aspects a criterion includes. Besides, they aim to enable critical analysis concerning the extent to which these aspects are incorporated in a project. These reflection questions can also serve as a foundation for conducting interviews, which is one of the possible ways to apply the assessment.

This approach of formulating a single, broad evaluation question per criterion with clear answering options is specifically designed to prevent the framework from becoming overly extensive. Instead of requiring respondents to answer multiple questions for each criterion, we have chosen to include reflection questions as optional, potentially helpful tools. This distinguishes our framework from The ORBIT Self-Assessment Tool (Stahl, 2017), which includes multiple evaluation questions for each RRI criterion, such as Anticipation or Governance. This might be useful to assess only one of our four concepts in a deeper manner, as it is the case in

the ORBIT Self-Assessment, focusing on RRI only. However, this approach is less feasible and less user-friendly if applied to four differing concepts, which must necessarily be kept simpler. Still, we have found value in the multiple ORBIT Self-Assessment questions and have incorporated some of them into our framework as reflection questions.

The concept of including self-reflection questions into our evaluation framework to enhance critical analysis was mainly inspired by the RRI self-reflection tool (RRI Tools Consortium, n.d.) and the New HoRRIzon Thinking Tool (New HoRRIzon Project Consortium, 2019). The RRI self-reflection tool is characterized by its focus on open-ended self-reflection questions and does not provide quantitative or visual outputs. In order to combine the strengths of both approaches, we integrated the structure of the SDG Impact Assessment Tool, which employs a systematic evaluation system using a Likert scale, with the RRI tool's emphasis on thought-provoking questions.

To construct the self-reflection questions, we followed a specific process. Firstly, we gathered descriptions of the criteria and questions from various sources used for evaluating those criteria. We then carefully selected the most relevant and precise questions and information that best suited our purposes. Next, we rephrased the selected input into reflection questions, ensuring consistency in style and alignment with our objectives. In some cases, we adapted existing questions, while in others, we created new ones based on the provided text. Throughout this process, we made sure to maintain the integrity of the original sources while also ensuring that the questions worked cohesively as uniform reflection questions. We give an example question adopted from the RRING project (Rosemann and Kgwadi, 2020) as part of the Social Justice, criterion: “If you conduct participatory research, for example through including local communities or indigenous populations, does it contribute to reduced inequalities through the distribution of the benefits of the research?” Participatory research is a crucial element of RRI (and RSSR), representing the Engage dimension of the AREA framework (ORBIT RRI, 2023). Social Justice corresponds to SDG 10.

In addition to fostering critical reflection on the alignment of the project with the framework’s criteria, the reflection questions also serve the purpose of highlighting the connections between different criteria and the four concepts which is a key objective of this holistic framework. For instance, Social Impact plays a significant role in the RRI dimension of Anticipation, which involves anticipating the social consequences of a project prior to its implementation. To capture this, we included the question "Do you consider the impacts of the project on human activities and employment?" among others. Furthermore, we integrated SDG 2 Zero Hunger into the Social Impact criterion through a self-reflection question, recognising the importance of possible impacts on food security.

As mentioned earlier, there are also linkages between RRI and SDGs. This connection is evident in criteria such as Social Justice, where we ask: "If you engage in participatory research, such as involving local communities or indigenous populations, does it contribute to reducing inequalities by distributing the benefits of the research?" These reflection questions allow for a comprehensive assessment of the project's impacts, promoting a deeper understanding of the interplay between RRI, Open Science, Social Impact, and SDGs within the framework.

In conclusion, our framework enables research and innovation projects in the EU Mission 'Restore our Oceans and Waters by 2030' to reflect on the four discussed concepts in relation to their project by using one holistic evaluation framework with manageable effort. Additionally, the framework enhances knowledge about these concepts which could support responsible and ethical research and innovation in the future.

6 Limitations and Outlook

In this concluding section, firstly, we address limitations of the current version of the framework and, secondly, outline our plans for its future development.

6.1 Limitations

To ensure the clarity of the results, we decided to standardise the Likert scale. This means that respondents are limited to providing answers ranging from 'to no extent' to 'to a great extent'. This approach excludes capturing negative impacts, which could be valuable for assessing Sustainable Development Goals (SDGs) or Social Impact. However, there are no negative contributions within the RRI-Process related keys, dimensions and Open Science. Therefore, we opted for a positive-only Likert scale as a common denominator for all four concepts to maintain consistency and comparability in the measurement.

Further, it is important to acknowledge that the evaluation framework is primarily designed for awareness raising, knowledge transfer, and self-reflection purposes rather than serving as an external, independent evaluation of projects. Consequently, the results obtained reflect the interpretations of the projects themselves. This limits their usefulness for purposes such as comparisons between different projects and publicity. Also, given its topics and nature as a self-reflection tool, the framework's scoring is generally less an exact irrefutable measurement, but rather helps providing orientation and tendencies.

The reflection questions provided are intended to assist projects in answering the main evaluation questions. However, they may not provide clear indications of how the answers correspond to specific levels on the Likert scale. Therefore, it remains uncertain whether the reflection questions adequately guide projects in formulating their responses. Additionally, the existing reflection questions, particularly regarding the SDGs, may need further refinement or potentially be substituted or expanded with additional reflection questions. This will aid in tailoring the framework more effectively to the specific needs and characteristics of the EU Mission projects. Moreover, the importance assigned to self-reflection can vary among projects, as some may find certain aspects more relevant than others.

Besides, the evaluation questions are formulated in present tense. This means that the current purpose, processes and products/consequences of the projects are evaluated. However, some projects might not yet have any outcomes, for example. That is why we might adapt the framework for some key stages that projects might find themselves in.

A main limitation of the framework is that it has not yet been tested by projects. Thus, its effectiveness cannot be determined yet. The application through case studies could provide insights on the relevance of the mentioned limitations, provide indications on how to address them, or shed light on further needs that the framework could address.

Despite the mentioned limitations, we regard the current framework as a successful and solid foundation that can be improved for the next Deliverable 5.9 in April 2025. In the next section, we explain how we aim to extend and refine the current version and bring it into application.

6.2 Next steps

For the further adaptation of the framework, we intend to use e.g. the method of a qualitative content analysis for identifying specific connections between the SDGs and ocean and water restoration. This will help to tailor the SDG criteria and corresponding self-reflection questions to better suit the EU Mission 'Restore our Oceans and Waters by 2030' projects. For this purpose, we are going to analyse pertinent literature as well as documents and websites related to the projects.

Additionally, we will also further discuss our work with partners from other work packages (WPs) of BlueMissionAA. We have already had an initial meeting with WP1 and WP3 and plan to have more exchanges on the necessities and features of the EU Mission projects. In specific, we believe that exchanges with partners of Tasks 1.3 and 2.1 can provide useful insights since their tasks necessitated an examination of the projects. These discussions will provide meaningful insights into the empirical world of the projects and help refine the framework.

With the feedback from and in discussion with our contributors to Task 5.3, we therefore plan to further adapt our draft holistic evaluation framework to the context of marine and coastal restoration and to the needs of projects using it as an assessment tool. We then plan to help our partners in Work Package 5 (Citizen Engagement and Knowledge Transfer) apply the holistic evaluation framework (1) in their mutual engagement activities with citizens, including civil society, researchers, indigenous and local communities, and local businesses and (2) in their knowledge transfer to relevant stakeholders with the measurable evaluation factors which our evaluation framework provides. We might also help other projects in the EU Mission 'Restore our Oceans and Waters by 2030' apply the holistic evaluation framework, potentially the six case studies selected as part of Milestone 3.2 within BlueMissionAA. Contact to these should be established in cooperation with our partners in BlueMissionAA. The application could take the form of an online questionnaire or an assessment tool, the use of which we could explain and accompany e.g. with information sessions or workshops. However, the exact forms remain to be specified. With feedback and experience we gain from these applications, we will further improve the holistic evaluation framework (for Deliverable 5.9, due in spring 2025) with the longer-term aim of making it available to projects across the EU Mission and potentially beyond, to create a lasting value. This ambition goes beyond the Grant Agreement, but seems sensible to us and our partners, as the well-applicable assessment tool uniting RRI, SDGs, Open Science and Social Impact which we developed avoids the use of multiple complex assessment tools and should be freely accessible to everyone. Nonetheless, the further implementation strategy will be oriented at our own resources in Task 5.3, the capacities of

Work Package 5 partners and projects applying our framework. It will also be flexibly adapted to findings we generate in the course of the project.

7 Holistic RRI, SDG, Open Science, Social Impact evaluation framework

Table 2 shows the holistic RRI, SDG, Open Science, Social Impact evaluation framework we developed. Its structure and functionality are explained in section 4. Sources we drew on to formulate the evaluation and the reflection questions are listed in the following. To keep the framework in a well readable format, we marked the source for each question with a superscript – corresponding to the superscripts of the following references. Questions without a superscript are developed by our team.

Sources for the framework's questions are:

- [1] AREA 4P framework (ORBIT RRI, 2023)
- [2] FAIR Principles (GO FAIR Initiative, n.d.)
- [3] International Principles For Social Impact Assessment (Vanclay, 2003)
- [4] New HoRRIzon Societal Readiness Thinking Tool (New HoRRIzon Project Consortium, 2019)
- [5] Road 2 Openness. Open Science Self Assessment (Stifterverband für die Deutsche Wissenschaft e.V., no date)
- [6] Rosemann and Kgwadi (2020)
- [7] RRI Self-Reflection Tool (RRI Tools Consortium, n.d.)
- [8] SDG Impact Assessment Tool (Wexsus and SDSN Northern Europe, n.d.)
- [9] SEEbalance® (Schmidt et al., 2004)
- [10] The ORBIT Keys of RRI (ORBIT, 2023)
- [11] The ORBIT Self-Assessment Tool (ORBIT, 2023)

Table 2: Holistic RRI, SDG, Open Science, Social Impact evaluation framework

Category & Criterion	Evaluation question	Scale	Reflection questions
Purpose			
Motivation behind your project	To what extent is addressing societal and planetary needs the main motivation of your project?	1 (no extent) – 5 (great extent)	What is the aim of your project? Does your project aim for positive social and ecological impacts? Are there other motivations for your project that compete with the objective of addressing societal and planetary needsof restoring ocean or water (e.g. financial, reputational,...)?

Motivation for engaging with Responsible Research and Innovation (RRI)	To what extent do you believe in the importance of engaging in Responisble Research and Innovation (RRI) practices?	1 (no extent) – 5 (great extent)	The concept of Responsible Research and Innovation (RRI) was officially introduced by the European Union through its research and innovation funding program, Horizon 2020, which was active from 2014 to 2020. RRI's main objective is to ensure that research and innovation, including their processes and outcomes, align with societal values and needs (source: https://rring.eu/impact/). For the operationalisation of RRI, the European Union developed the six keys of RRI: Ethics, Science Education, Gender Equality, Open Access, Governance and Public Engagement (https://orbit-rri.org/resources/keys-of-rri/) which will be addressed in the following.
Process			
Anticipation (RRI, Social Impact & SDG 2 Zero Hunger)	To what extent do you anticipate consequences of your project?[11]	1 (no extent) - 5 (great extent)	Do you consider positive and negative consequences of your project? Do you have mechanisms in place to include a broad and diverse range of stakeholders when considering the consequences of your research?[11] Do you consider the consequences of the project on different cultures?[11] Do you consider the impacts of the project on human activities and employment? Do you promote zero hunger (SDG 2)? Do you consider whether your project will influence people's behaviour, attitude, emotions, thoughts, moods, and actions?[11] Do you consider the social impact for the whole life cycle of your product (production, use, disposal) and all procedures for every step of your project (planning, process, outcome, impact)? Do you consider all consequences that the project may have on the environment?
Reflection (RRI)	To what extent do you reflect on the purpose, processes and outcomes of your project?	1 (no extent) - 5 (great extent)	Do you question your axioms and basic assumptions to ensure the research is aligned with societal needs? Do you include reflexivity in your work? Does your project include mechanisms for reflection, e.g. internal workshops, socio-technical integration, backcasting/hindsight analysis, a project advisory board, stage-

			gating processes, review and quality assurance steps?[10, 11] Do you consider the potential of your work to raise ethical, social or political controversy?[11] Do you think about possible alternate uses and abuses of your work?[11]
Engagement (RRI) & SDG 17 (Partnerships for the Goals)	To what extent is public engagement part of your research process?	1 (no extent) - 5 (great extent)	Do you use participative research methods? How might the project benefit from involving stakeholders?[11] Do you use an adequate methodology to identify stakeholders?[4] Have relevant stakeholders been involved in defining the research problem?[11] How will you ensure that all stakeholders have the information they need to engage in a meaningful dialogue?[4] Do you ensure that all stakeholders feel adequately supported to voice their opinion?[4] How will you ensure that you maintain good relations with your stakeholders?[4] Have the results been discussed with different types of stakeholders to allow for alternative interpretations?[4]
Ethics (RRI)	To what extent are research ethics incorporated into your research process?	1 (no extent) - 5 (great extent)	Does a comprehensive ethics approval exist for your work?[11] Does your project involve any risks of breach of confidentiality and what might they be?[4] Does your data collection require informed consent from the participants?[4] Is the planned research methodology ethically acceptable, including aspects related to data collection, data management and data storage?[4] Do you hold critical peer review and internal discussion on research integrity throughout the process?[7] Do you consult an external research ethics expert or ethics committee?[7] Do you share the responsibility for the impact of your research among all actors involved (researchers, policy makers, research institutions, universities, industry, civil society organisations, etc.)?[7]
Governance (RRI)	To what extent do governance	1 (no extent) -	Do you have transparent internal procedures?[10]

	instruments exist in your project to promote Responsible Research and Innovation (RRI)?	5 (great extent)	Are you encouraging future-oriented governance?[10] Are you investing resources to make your research more responsive to societal needs and concerns?[7] Do you ensure that your research practices can adapt to unforeseen results or societal changes (e.g. agile project management, recalibrating the vision of the project)?[1, 7] What RRI-related training opportunities do you have (regarding gender equality, ethics, open science, research integrity, research management, data management)? [1, 7]
Product / Outcomes			
Gender Equality and Diversity (RRI and SDG 5 Gender Equality)	To what extent does your project promote gender equality and diversity?	1 (no extent) - 5 (great extent)	Do you consider sex and gender in your chosen topics, methodology and data?[7] Do you have a plan to promote Equality, Diversity and Inclusion (EDI) in your project (including gender-balanced teams and management positions, equal salary guarantees and contract conditions, support of diverse working approaches, avoiding gender stereotypes, gender sensibility in publications, evaluation of gender equality)?[11] Do you consider EDI when evaluating the impact of your project?[11] Do you have a procedure in place for raising concerns regarding EDI?[11]
Science Education (RRI & SDG 4 Quality Education)	To what extent does your project promote science education for citizens?	1 (no extent) - 5 (great extent)	Do you think some of your research outputs should be accessible to the general public?[11] Do you equip citizens with the necessary knowledge to engage in debates around research and innovation?[11] Do you actively create and exploit science education opportunities?[11] Do you help people to acquire the knowledge and skills needed to promote sustainable development (including, amongst others, the criteria of this framework)?[8]
Open Science	To what extent does your project promote Open	1 (no extent) - 5 (great extent)	Do you provide free and early access to your research, its data and findings in order to improve its quality and facilitate fast innovation?[7]

	Science (as open as possible and as closed as necessary)?[5]		Do you adhere to the FAIR Principles (guidelines to improve the Findability, Accessibility, Interoperability, and Reuse of digital assets, emphasising machine-actionability; cf. for example: https://www.go-fair.org/fair-principles/)?[5] Is the open access information accompanied by a transparent documentation of the data structure, data editing, statistical procedures and analytical decisions made throughout the project (allowing for replication)?[4] Do you have communication channels to allow for a co-production of knowledge across different sectors and cultures?[6] Do you promote Open Science to benefit the Sustainable Development Goals (SDGs)?[6] Are you able to balance commercial interest with the need for open access?[11]
Social Impact (SDG 3 Good Health and Well-Being)	To what extent does your project improve people's lives?[3]	1 (no extent) - 5 (great extent)	Does your project at any stage (planning, process, outcome, consequences) ... ... improve how people live or work together or how they interact with each other?[3] ... promote culture? [3] ... improve people's living environment?[3] ... improve people's economic situation?[3] ... improve people's health and wellbeing?[3] (SDG 3: Good Health and Well-Being)
Social justice and inclusion (SDG 1 No Poverty, SDG 10 Reduced Inequalities, SDG 16 Peace, Justice and strong Institutions)	To what extent does your project promote social justice?	1 (no extent) - 5 (great extent)	Do you consider social justice as part of your research focus, design and practices? Does your research address social inequalities (e.g. in terms of economic resources, opportunities, education, health)? Do you promote no poverty (SDG 1)? Does your research impact on social inequalities (e.g. affect particularly poorer citizens, target poorer or richer citizens more in aiming for behavioural change)? Do you promote peace, justice and strong institutions (SDG 16)?[8] Do you promote participation of communities and indigenous people in your research to establish the connection between science and society?[6] If you conduct participatory research, e.g. by including local communities or indigenous

			populations, does it contribute to reduced inequalities through the distribution of the benefits of the research?[6] Do you ensure that the resulting knowledge from this exchange is appropriately credited?[6] Do you have collaborations with other developed and developing countries to help bridging the knowledge gap between rich and poor countries?[6] How could your Open Science policies influence social equality, for example through access to knowledge?
Clean Water and Sanitation (SDG 6)	To what extent does your project promote clean water and sanitation (SDG 6)?[8]	1 (no extent) - 5 (great extent)	Do you contribute to good access of safe and affordable drinking water?[8] Does your project protect and restore water-related ecosystems?[8] Does your project increase water-use efficiency and ensure freshwater supplies?[8] Does your project improve water quality, wastewater treatment and safe reuse?[8] Do you support local engagement in water and sanitation management?[8] Do you implement integrated water resources management?[11]
Industry, Innovation and Infrastructure (SDG 9)	To what extent does your project support industry, innovation and infrastructure (SDG 9)?	1 (no extent) - 5 (great extent)	Do you develop sustainable, resilient and inclusive infrastructures?[8] Do you promote inclusive and sustainable industrialization?[8] Do you upgrade industries and infrastructures for sustainability?[8] Do you enhance research and upgrade industrial technologies?[8] Do you support domestic technology development and industrial diversification?[8] Do you facilitate sustainable infrastructure development for developing countries?[11]
Sustainable Cities and Communities (SDG 11)	To what extent does your project contribute to sustainable cities and communities (SDG 11)?	1 (no extent) - 5 (great extent)	Do you protect the world's cultural and natural heritage?[8] Do you foster inclusive and sustainable urbanization?[8] Do you promote decent work and economic growth (SDG 8)?[8] Does your project try to reduce the adverse effects of natural disasters?[8] Does your project reduce the environmental

			impact of cities?[8] Do you provide access to safe and inclusive green and public spaces?[11] Do you implement policies for inclusion, resource efficiency or disaster risk reduction?[11]
Responsible Production and Consumption (SDG 12)	To what extent does your project promote responsible production and consumption (SDG 12)?	1 (no extent) - 5 (great extent)	Do you use natural resources in a sustainable way?[8] Do you have a responsible management of chemicals and waste?[8] Do you reduce waste generation?[8] Do you promote a universal understanding of sustainable lifestyles?[8] Do you support developing countries' scientific and technological capacity for sustainable production and consumption?8 Do you evaluate the environmental impact of your research (including facilities, travels etc.)?[11]
Climate Action (SDG 13)	To what extent does your project promote climate action (SDG 13)?	1 (no extent) - 5 (great extent)	Does your project strengthen resilience and adaptive capacity to climate related disasters?[8] Does your project build knowledge and capacity to meet climate change?[8] Does your project promote raising capacity for effective climate change-related planning and management?[8] Does your project integrate climate change measures into policies and planning?[8] Does your project support affordable and clean energy (SDG 7)?[8]
Life below Water (SDG 14)	To what extent does your project promote life below water (SDG 14)?	1 (no extent) - 5 (great extent)	Does your project reduce marine pollution?[8] Does your project conserve, protect or restore marine or coastal ecosystems?[8] Does your project reduce ocean acidification?[8] Does your project support sustainable fishing or support small scale fishers?[8] Does your project increase scientific knowledge, research and technology for ocean health?[8] Does your project implement and enforce international sea law?[8] Does your project increase the economic benefits from a sustainable use of marine resources?[8]

Life on Land (SDG 15)	To what extent does your project promote life on land (SDG 14)?	1 (no extent) - 5 (great extent)	Does your project conserve and restore terrestrial and freshwater ecosystems? Does your project end desertification and restore degraded land?[8] Does your project prevent invasive alien species on land and in water ecosystems?[8] Does your project eliminate poaching and trafficking of protected species?[8] Does your project protect biodiversity and natural habitats?[8]

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