Deliverable D6.1

Mapping the UNESCO Recommendations on Science and Scientific Researchers to the UN Sustainable Development Goals

RRING (Responsible Research and Innovation Networked Globally)
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Glossary of Key Terms

Responsible Research and Innovation (RRI)

Responsible Research and Innovation (RRI) is an approach to research and innovation that anticipates and assesses potential implications and societal expectations involved in research and innovation, so as to foster the design of inclusive and sustainable processes of knowledge production. RRI implies that societal actors (researchers, citizens, policy makers, business, third sector organisations etc.) work together during the whole research and innovation process in order to better align research and innovation outcomes to the values, needs and expectations of society. It is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (fostering a proper embedding of scientific and technological advances in our society).

RRING geographic regions:

RRING adopts the United Nations Educational, Scientific and Cultural Organisation's (UNESCO) Executive Board Grouping of its 193 member countries into five regional groups: Europe and North America, Latin America and the Caribbean, Asia and the Pacific, Africa and Arab States (UNESCO, 2020). The list of countries under each geography is provided in appendix 2.

RRI Keys

The key pillars of RRI are: gender equality, science education, public engagement, open access, ethics and governance.

Process dimensions of RRI

RRI process dimensions include anticipation, inclusion, reflexivity and responsiveness (AIRR).

Sustainable Development Goals

The 17 interconnected goals set out in the 2030 Agenda for Sustainable Development, with 169 targets and 231 unique indicators, which cover social, economic and environmental issues. The goals are all interconnected. The 2030 Agenda for Sustainable Development is a Resolution adopted by the United Nations General Assembly in 2015 which lays out global development until 2030. The 2030 Agenda requires a holistic approach, rather than the North- South approach of the previous Millennium Development Goals (MDGs).

UNESCO Recommendation on Science and Scientific Researchers (RSSR)

The UNESCO Recommendation on Science and Scientific Researchers "are a standard-setting instrument which codifies the goals and value systems by which science operates". It also emphasizes "that these need to be supported and protected if science is to flourish". (UNESCO 2018).[1]

Indigenous knowledge

The understandings, skills and worldviews developed by societies with long histories of interaction with their natural surroundings. Indigenous knowledge informs decision-making about fundamental aspects of day-to-day life. This knowledge is integral to a cultural complex that also encompasses language, systems of classification, resource practices, social interactions and spirituality. These

[1] https://www.unescosost.org/post/recommendation-on-science-and-scientific-researchers

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unique ways of knowing are important facets of the world's cultural diversity, and provide a foundation for locally-appropriate sustainable development.

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Acronyms

EU	European Union
RFOs	Research Funding Organisations
RPOs	Research Performing Organisations
RRI	Responsible Research and Innovation
RRING	Responsible Research and Innovation Networked Globally
RSSR	Recommendation on Science and Scientific Researchers
SDGs	Sustainable Development Goals
S&T	Science and Technology
STI	Science, Technology and Innovation
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN	United Nations
AIRR	Anticipation, Inclusion, Reflexivity, Responsiveness (process dimensions RRI)

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Introduction

This Deliverable aims to align and integrate the 2017 UNESCO Recommendation on Science and Scientific Researchers (RSSR) and the 17 United Nation's Sustainable Development Goals (SDGs). The RSSR is an international standard-setting instrument that "codifies the goals and value systems by which science operates". Signed by 195 UNESCO member states, it calls on "states and their governments to create the conditions that will enable science to flourish and advance, to be practiced ethically and fairly, and to be useful and relevant to society" (UNESCO 2017).[2] Aimed at individual researchers, research performing organizations, including in the private sector, as well as government bodies and other organizations that guide, fund or conduct research, the RSSR serves as an international reference for addressing the ethical and regulatory challenges that affect how science, scientific research and science society relationship are practiced and governed in the 21st Century (UNESCO 2017).[3] The 17 SDGs were adopted by the United Nations (UN) in 2015, and form the core of the UN's 2030 Agenda, which aims to reduce global inequalities, "end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030" (UN 2015).[4] Implemented in all UN member states, and supported through public and private funds and a wide range of stakeholders, Agenda 2030 and the 17 SDGs have become the central global framework to tackle the most pressing social, economic and environmental challenges that the world is currently facing. The RSSR and the SDGs share a set of overarching commitment, such as sustainable development, peaceful global relations, human welfare, and the promotion of science as a common good. However, the nature and functions of the two frameworks differ in fundamental respects. While the SDGs seek to engender solutions to the world's most urgent problems, the RSSR serves as a normative framework to ensure that scientific research and its applications are socially focused, aligned with recognised ethical standards and comply with the international framework of human rights.

Science and technology-based innovation processes are central to the realization of the SDGs and many of the 169 SDG targets (World Economic Forum 2020).[5] However, as the history of science and innovation shows, the development and application of new scientific solutions is rarely without problems. These can include, for example, the emerging of new types of risks, including for human health, unintended societal implications, and possible adverse effects on the environment and ecosystems. Moreover, scientific research and development take place in a context of global inequalities, different political and regulatory systems, cultural values, and often precarious employment. These factors can lead to labour exploitation, disregard of the needs of local communities, including indigenous populations, unequal forms of benefit sharing, ethics dumping, and other problems (Schroeder et al. 2019).

The RSSR has a crucial role to play in addressing and preventing these challenges, including in the context of the SDGs. As we will show in this Deliverable, the integration of the RSSR into science-based efforts to achieve the SDGs offers new ways and perspectives that can help to improve the implementation of the SDGs, and to make the realization of the SDGs more responsible, ethically robust, and aligned with the needs of communities and the environment.

The aims of this Deliverable are as follows:

- To provide new perspectives, ideas and approaches that can help to improve the implementation of the SDG, by facilitating the integration of RRI-related aspects of the RSSR into science-based solutions to realise the SDGs, to make them more achievable, ethically robust, socially focused and environmentally conscious.

[2] https://en.unesco.org/themes/ethics-science-and-technology/recommendation_science
[3] https://unesdoc.unesco.org/ark:/48223/pf0000366770
[4] https://www.undp.org/content/undp/en/home/sustainable-development-goals.html; https://sdgs.un.org/2030agenda
[5] http://www3.weforum.org/docs/Unlocking_Technology_for_the_Global_Goals.pdf

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- Develop a set of recommendations, that provide ideas on how aspects of the RSSR can be integrated and achieved at the level of **(i)** national and international policy (making), **(ii)** future research and innovation projects (in industry and academia), as well as **(iii)** education and training of researchers, policy makers and other stakeholders.

To achieve these aims, the Deliverable asks three questions:

- What is the significance and role of the RSSR in relation to the SDGs?
- How can the RSSR help to improve SDG implementation?
- How can (specific aspects of) the RSSR be integrated into efforts to achieve the SDGs?

In order to achieve these aims, and to answer the three questions, we developed a methodology that systematically maps the RSSR to the SDGs, from a variety of perspectives. This will be explained now.

Methodology

Mapping the RSSR to the SDGs

This Deliverable is based on six team reports that have coded and analysed the RSSR, and then mapped identified themes to the SDGs. Each team worked on one of the following six RRI dimensions: (1) Ethics and Ethical Governance of Research and Innovation; (2) Gender Equality, Diversity and Inclusion; (3) Public and Multistakeholder Engagement; (4) Public and Multistakeholder Engagement; (5) Education, STEM and sustainable research careers; and (6) Human Rights. The first five of these themes are based on the RRI Keys (Egeland, Forsberg and Maximova-Mentzoni 2019).[6] We have added the Human Rights theme, because human rights play an important role both in the RSSR and the SDGs, and are important legal instruments in the governance of research and development at an international level.

Each team was asked to code the RSSR in relation to one of these dimensions, and then, in a second step, to identify connections and synergies between the identified aspects of the RSSR and the SDGs. Because the RSSR refers mainly to science and technology (S&T) research, and the innovation, transfer and applications of such research, the key aim of the process was to tease out and discuss the ways in which specific RSSR aspects can be applied in the context of S&T-based solutions to the SDGs. This includes a concern with the broader structural, societal and cultural factors that enable or prevent access to scientific benefits, including access to the advantages of S&T-driven forms of social and economic development, as well as possible side effects and risks of science-based innovation on human welfare, societies and the environment. It also included a concern with access to science education and scientific careers, especially in a context of global inequalities, which plays a central role in the RSSR.

To achieve these aims, RRING developed a methodology, that involves three steps:

- The coding of the RSSR
- The mapping of identified aspects of the RSSR onto the SDGs
- The development of recommendations, that help to implement the RSSR in the context of science-based efforts to the SDGs

To facilitate the analysis we developed three analytical tables (APPENDIX A), which correspond to the three steps above. The tables served as tools to structure the coding analysis, to identify connections between the RSSR and the SDGs, and to generate related ideas and recommendations.

[6] https://www.tandfonline.com/doi/pdf/10.1080/23299460.2019.1603570

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The main findings of the analysis were then developed and presented in the six team reports, which constitute Chapters 1 - 6 in this Deliverable.

Step 1: Coding the theme-specific dimensions in the RSSR

The analytical process used the RSSR as the source of reference. This involved the coding and analysis of all concepts, principles, ideas, goals, recommendations, procedures, etcetera, in the RSSR, that relate to the RRI dimension that each team examined. The first of the three analytical tables, served as a combined code book and data matrix for each team. Each team was asked to identify overarching categories (aggregate codes), as well as corresponding codes and sub-codes, that emerged from the theme-specific analysis of the RSSR. Each code and subcode had to be illustrated through a text excerpt. Because the RSSR is a single document that contains just below 6200 words, each team used the code book also as a data matrix. This means, all text excerpts that relate to a sub-code or code in the code book are listed in the document. This provides immediate access to all relevant text passages, that relate to a specific code or category.

In contrast to a conventional code book, which lists the code categories that are used for the coding and analysis of a larger number of texts (for example interviews), the code books that were designed in this task served as a device to systematically examine and break down the specific themes, concepts and normative ideas through which the RSSR addresses each of the six RRI dimensions that the teams explored. Each team consisted of two persons who first of all coded the RSSR independently, then got together to compare, discuss and strengthen the results. One purpose of the independent coding was to introduce a check and balance system that would increase the reliability of the codes the two partners identified (since we were dealing with a single document, a mathematical inter-coder reliability test was obviously out of question). A second and more important purpose of the independent initial coding of the RSSR was to utilize the different perspectives and expertise of the two researchers, to identify themes and generate ideas that were complementary to each other, and which could strengthen the analysis as a whole. Identified aspects and themes that emerged from the codes, were then in a second analytical step, mapped onto the SDGs.

Step 2: Mapping identified RSSR aspects onto the SDGs

The second step involved the identification of possible connections and synergies between specific themes and aspects that emerged from the analysis of RSSR in Step 1 above, and the SDGs. The objective of this process was to tease out and discuss the different ways in which relevant aspects of the RSSR can be linked to the SDGs, and be applied in science-based strategies to realise the SDGs. This involved an engagement with the contents and aims of the SDGs at a more general level (i.e., a discussion of the role and significance of a specific RSSR aspect across all SDGs, or groups of SDGs) and at the level of individual SDGs or SDG targets. (For more details, please see Table 2 in APPENDIX A).

Chapters 1 – 6 below, present the findings from this alignment process in Section 2..2 of each chapter. These Sections are structured along a small number of overarching themes that have emerged from the analysis of the RSSR in Step 1 above. Most of the chapters have broken down each of these themes in a number of sub-themes, that represent a specific aspect of the RSSR. Each sub-theme is discussed in a different section, which (in most cases) follows a three-step structure: (1) a brief summary of the specific RSSR aspect(s) that shall be linked to the SDGs; (2) a discussion of the possible role, value and significance of the RSSR aspect(s) to the SDGs at a more general level (e.g., across all or several SDGs); and then (3) an exploration of the possible role, value and contribution of the discussed RSSR aspect(s) to two or three specific SDGs (or SDG targets). Because the systematic mapping of each RSSR aspect to each of the 17 SDGs, or even 169 SDG targets has for practical reasons not been possible, we decided to choose specific SDGs or SDG targets as illustrative examples. In this way, the significance

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of selected RSSR aspects to the SDGs is explained at a more general level, and simultaneously at the level of at least some individual SDGs.

Step 3: Generating Recommendations

The final Step involved the generation of recommendations, which spell out how specific RSSR aspects can be promoted and actively applied to science-based solutions to achieve the SDGs. (Table 3 in APPENDIX A). These recommendations aim to ensure that the alignment process of the RSSR and the SDGs, which has been initiated in the context of this Deliverable, will be developed further and implemented by diverse stakeholders in SDG-related research and development initiatives.

Outline of the Deliverable

Part I, which consists of chapters 1–6 include the six team reports. Part II involves three additional chapter. Chapter 7, which is a reflective analysis of the relationship between RRI and SDGs in the context of research performing organizations. This chapter engages with the 6 previous chapter, through a case study of indigenous knowledge. Chapter 8 is a discussion of key findings from the six reports and relevant aspects of chapter 7. Chapter 9 present a set of final recommendations that arise from the analysis and different chapters.

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Part I: Mapping the RSSR onto the SDGs

Chapter 1: Ethics and Ethical Governance of Research and Innovation

Achim Rosemann, Fabio de Castro and Kutoma Wakunuma

1. Introduction

This Chapter presents findings from the analysis of the Ethics and Ethical Governance theme. The findings from the coding and mapping process are introduced in 3 parts. Part 1 presents the key results from the coding of the RSSR. This includes an overview of the central themes and principles through which the ethical and ethical governance dimensions of research and innovation have been defined and operationalised in the RSSR. Part 2 maps identified aspects and themes onto the SDGs, exploring both possible contributions to the SDGs as a whole, and more specific contributions. Part 3 provides a series of initial draft recommendations, that shall help to facilitate the integration of the RSSR in the ongoing efforts to achieve the RSSR in practice.

1.1. Results theme-specific analysis of RSSR:

The coding and analysis of the RSSR has involved the systematic categorization of text excerpts in order to identify themes and patterns related to the overarching ethics and ethical governance of research and innovation theme. Table 1 in the Appendixes Section below, contains the identified aggregate codes, codes and subcodes in the first and second row on the left. The corresponding text excerpts and text locations are listed in the third and fourth row from the left in the middle of the document.

This section provides an overview of the ways in which ideas, concepts and principles related to the ethics and ethical governance of research and innovation are defined and operationalised in the RSSR. Findings are structured around 6 central themes that emerged from the analysis. These are:

- Ethical commitments in the RSSR
- Ethical concerns raised in the RSSR
- Ethical responsibilities of researchers
- Ethical responsibilities of government bodies, institutions and individuals that fund, govern and guide research
- The ethical dimensions and requirements of international science collaborations
- Pathways to implement ethics in research and innovation

1.1.1 Ethical commitments in the RSSR

The RSSR conveys a set of central ethical commitments that articulate the role and contributions of science and technology research, and the conditions and requirements under which research and development is conducted and applied.

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1.1.1.1. A commitment to responsible and peaceful applications of science

A key directive in the RSSR is "to advance the objectives of international peace and of the common welfare of humankind" (Preamble). This involves a commitment to the "responsible and peaceful application of science and technology" (5e), the "promoting of research and development that may address peacebuilding" (5, e), "addressing the root causes and impacts of conflicts" (5, f), and the "utilization of science [for] the reduction of international tensions" (Preamble a).

1.1.1.2. A commitment to address global challenges, including social and ecological challenges

The RSSR mandates an "enhanced spirit of responsibility towards humankind and the environment" (Preamble d). This encompasses recognition of the "social and ecological responsibilities [of research and researchers] toward […] fellow nationals, humanity in general, future generations, and the earth including all its ecosystems" (12, d). The RSSR recommends, that states and other stakeholders give "recognition to the key role of research […] in achieving sustainable development" (5, f), contributing to the "alleviation of urgent global health problems" (19), and other global challenges. It also demands, that "researchers […] minimize the impacts on living subjects of research and on the natural environment", and are "aware of the need to manage resources efficiently and sustainably" (13, d).

1.1.1.3. A commitment to support indigenous research and the building of innovation capacity in developing countries

A third ethical commitment in the RSSR is to support the development of indigenous research around the world, in particular in developing countries. The RSSR states in this regard, that UNESCO member states should recognise "the paramount needs of developing countries" and "assist in the creation of [...] conditions which encourage and assist indigenous capability" (Preamble, d). This includes, "adequate support and essential equipment for performance of research and experimental development" (Preamble, d), and the recognition that "research should be responsive to the needs of host countries", especially in the context of international research (19, b).

1.1.1.4. A commitment to inclusive research and development and broad access to innovation benefits

The RSSR's mandate for inclusive research and development includes two dimensions: equal access to science education and careers, and broad access to innovation benefits. The RSSR's commitment to equal access to science education and scientific careers is explored in more detail by partners from UPM, but we have included this theme here, because the RSSR states that broad access to science is "not only a social and ethical requirement for human development, but also essential for realizing the full potential of scientific communities worldwide" (18, b)".

Broad and inclusive access to the benefits of research and development is another key directive in the RSSR. The document states that "member States should demonstrate and take action such that R&D is not carried out in isolation but as an explicit part of the nations' integrated effort to set up a society that will be more human, just and inclusive, , for the protection and enhancement of the cultural and material well-being of its citizens in the present and future generations" (4). With regard to health research, the RSSR mentions that "so to ensure the human right to health, Member States should take measures so that benefits resulting from any research and its applications are

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shared with society as a whole and within the international community, in particular with developing countries" (22).

1.1.1.5. A commitment to a strengthen interaction between science and society and consultation with communities

Another way through which the RSSR promotes inclusiveness is through the engagement of scientific communities with society and local communities. This should include, "a vigorous and informed democratic debate on the production and use of scientific knowledge, and a dialogue between the scientific community and society" (5, c). The RSSR describes these actions as vital for the "strengthening [of] scientific culture, public trust and support for sciences throughout society" (5, c).

A related recommendation is "consultations with communities where the conduct of research may affect community members" (16, a, ii). Community consultation is portrayed as one of several "conditions that can deliver high-quality science in a responsible manner" (16), including in the context of international research collaborations. The RSSR commends in this regard, that "when negotiating a research agreement and terms for collaboration, agreement on the benefits of the research and access to the results should be established with full participation of the communities concerned" (20, c).

1.1.1.6. A commitment to scientific freedom and protection of the political rights of researchers

Another set of directives in the RSSR concerns scientific autonomy and the political rights and circumstances under which research and development work is taking place. The RSSR states in this regard, that scientific research "should be promoted in national policy on the basis of utmost respect for the autonomy and freedom of research", which is portrayed as "indispensable to scientific progress" (10).

A related term concerns the pursuit of truth. The RSSR enunciates that "to work in a spirit of intellectual freedom to pursue, expound and defend the scientific truth as [researchers] see it" (16, a, i), is a fundamental right for researchers, and a central aspect of "intellectual freedom, which should include protection from undue influences on their independent judgement" (16, a, i). As a part of this freedom, researchers must have the right to "express themselves freely and openly on the ethical, human, scientific, social or ecological value of certain projects" (16, a, iii). Moreover, in circumstances where the "development of science and technology [threatens to] undermine human welfare, dignity and human rights or is "dual use", they have the right to withdraw from those projects if their conscience so dictates and the right and responsibility to express themselves freely on and to report these concerns" (16, a, iii).

1.1.1.7. A commitment to public accountability and the disclosure of conflicts of interests

The RSSR counterbalances researchers' rights for autonomy and scientific freedom with a set of responsibilities that aim to make research and development accountable to society and the general public. It states that "Each Member State should institute procedures adapted to its needs for ensuring that, in the performance of research and development, scientific researchers respect public accountability while at the same time enjoying the degree of autonomy appropriate to their task and to the advancement of science and technology." A recommended way to achieve public accountability, is through the disclosure of "both perceived and actual conflicts of interest according

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to a recognized code of ethics that promotes the objectives of scientific research and development" (10).

1.1.1.8. A commitment to science-based decision making, including in policies for international relations

A further ethical commitment in the RSSR concerns the use of scientific knowledge for processes of decision making, both on the direction of science and for policies that influence international relations and treaties. The RSSR conveys in this respect, that "member states should use scientific and technological knowledge in decision-making and policies for international relations, for which they should strengthen capacities for science diplomacy" (7). The RSSR's above-mentioned directives to protect scientific research and researchers' independent judgement from "undue influences" and "conflicts of interests" that might affect evidence-based decision making, is also relevant in this regard.

1.1.1.9. A commitment to research integrity and respect for ethical principles

A final mandate that the RSSR spells out is a commitment to research integrity and compliance with ethical principles, as articulated in national and international regulations, law, and other regulatory instruments. As the RSSR point out, "scientific research calls for scientific researchers of integrity and intellectual maturity, combining high, intellectual qualities and respect for ethical principles" (12). This includes, "the adoption and application of this Recommendation, the great diversity of the laws, regulations and customs which, in different countries, determine the pattern and organization of research work and experimental development in science and technology" (Preamble, d). The directive to adhere to both, national and international standards is especially significant in the context of international research collaborations, where regulatory differences between countries allow researchers to strategically avoid regulatory requirements, that would apply in their home countries.

1.1.2. Types of ethical concerns raised in the RSSR

1.1.2.1. Dual use, misuse and problematic side effects of scientific discoveries and related applications

The RSSR recognises, that in addition to the positive contributions that science can make, research can also create dangers to societies and the natural environment, that result from dual use, misuse or possible side effects of science and innovation. In its Preamble, the RSSR states in that regard, that "scientific discoveries and related technological developments and applications [also] entail certain dangers, which constitute a threat, especially in cases where the results of scientific research are used against humankind's vital interests" (Preamble, a, 1). These can comprise the use of science and innovation to "prepare wars involving destruction on a massive scale", or "for purposes of the exploitation of one nation by another", or other applications that are to the detriment of human rights or fundamental freedoms or the dignity of a human person", and which can cause "complex ethical and legal problems" (Preamble, a, 1).

1.1.2.2. Illicit and socially problematic activities that are enabled by scientific advances

The RSSR acknowledges that scientific advances can not only result in illegal research, that violates existing laws and regulations, but also in the surfacing of illegal and socially problematic activities and practices, such as "biopiracy, illicit trafficking of organs, tissues, samples, genetic resources and

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genetic-related materials […] or personal data" (18, e), which can pose a threat to "the protection of […] human rights, fundamental freedoms and dignity of the human person" (18, e). These examples serve as illustrations for other illicit or problematic activities enabled by science, not mentioned in the RSSR, such as for instance, the selling of unverified medical interventions, the production and trade of synthetic narcotics, the use of digital data for unauthorised surveillance, and others.

1.1.2.3. Lack of acknowledgment and exploitation of traditional, indigenous and other knowledge sources

Another ethical concern that the RSSR raises, is the scientific or economic exploitation of "traditional, indigenous, local, and other knowledge sources", without acknowledgement, compensation, or other forms of benefit sharing (16, a, iii). These "native" knowledge sources can be researchers in developing countries, farmers, local medics, traditional healers or other actors who possess, for example, ethnobotanical and other traditional knowledges that can inform scientific research, development or new business practices.

The value of including indigenous, local and traditional knowledge forms in research and development, for example in the context of research on ecosystem management (Dudgeon 2005), or to understand the context and perceptions in communities that will be affected by technological developments, has been increasingly recognised (Gardner and Lewis 1996; Williams, Sikutshwa and Shackleton 2020).

To prevent that "traditional, indigenous, local, and other knowledge sources" are exploited and remain unrecognised, the RSSR demands that "knowledge derived from "these and other" sources, is appropriately credited, acknowledged, and compensated as well as to ensure that the resulting knowledge is transferred back to those sources.

1.1.3. Ethical Responsibilities of researchers

In order to address the social and ethical dimensions of scientific research and development, and in order to achieve the above-mentioned ethical commitments at the level of actual practice, the RSSR spells out a number of ethical responsibilities for researchers, as well as funders and regulators of research (see next section).

1.1.3.1. Search and defend the truth, and speaking truth to power

The RSSR directs researchers to search and defend the truth (16, a, i), and to speak publicly when projects pose a threat to human welfare, human rights or the natural environment (16, a, iii). This includes the responsibility to explore and disclose conflicts of interests (16, a, vi).

1.1.3.2. Plan and develop research that is humanely, scientifically, and ecologically responsible, and vigilance to possible social and ecological consequences

Another responsibility that the RSSR articulates, is that researchers plan, develop and contribute to research projects in ways that are "humanely, scientifically, and ecologically responsible" (16, a, ii).

This includes "vigilance as to the probable and possible social and ecological consequences of research and development activities" (14, d, v) as well as "dual use" applications (14, d, v). It also includes the responsibility to adhere to ethical principles, codes, regulations and laws (12), including in the context of international research collaborations (20; 20, a; Preamble, d).

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1.1.3.3. Balancing between contributions to science and development at a national level, and the furthering of international ideals and objectives

Another responsibility is to find a balance between researchers' contribution to science at the national level, and the furthering of international ideals and objectives. The RSSR mentions in this regard, that scientific researchers should "contribute constructively […] to the promotion of science and innovation in their own country, [the] achievement of national goals, the enhancement of their fellow citizens' well-being, [and simultaneously to] the protection of the environment, and the furtherance of […] international ideals and objectives)16, a, iv). This term is relevant especially in the context of countries with strong nationalist ideologies, populist movements or in authoritarian states, where nationalist interests can outweigh a commitment to shared global problems and goals.

1.1.3.4. The protection of human research subjects and the social and natural environment in which research is carried out and applied

A further ethical responsibility, as laid down in the RSSR, relates to the protection of human research subjects, and the social and natural environmental environment in which research is carried out and applied. This includes the need for fully informed consent and the use of "controls to minimize harm to each living subject of research, and to the environment", in which research takes place or shall be applied (16, a. vii). This can involve, if necessary, consultation with communities to investigate how research may affect community members (16, a. vii), and the way they interact with the environment or natural resources.

1.1.3.5. Share scientific data and insights between researchers, policy makers and society

Other responsibilities are the requirement to share "scientific data between researchers, and to policymakers, and to the public wherever possible, while being mindful of existing rights" (16, a. v). This relates to another term of the RSSR, which defines the "willingness to communicate with others not only in scientific and technological circles but also outside those circles", as a necessary "personal quality" of researchers (14, d, vi). It also relates to the RSSR's commitment to strengthen interaction between science and society, and to strengthen public trust and support for scientific research through a robust and informed democratic debate (5, c).

1.1.3.6. Ensure acknowledgment of knowledge sources and adequate benefit sharing

Still another responsibility is to ensure that knowledge sources, including from indigenous, traditional and local contexts are appropriately credited and compensated, and that – if possible – benefits that results from these knowledge forms are transferred back to their sources (16, a. vii).

1.1.4. Ethical Responsibilities of institutions or persons that fund, guide or govern research

1.1.4.1. Adhere to and promote the ethical responsibilities of researchers as defined above

The RSSR specifies that institutions or persons that fund, guide or govern research must themselves adhere to the ethical responsibilities spelled out above (16, b, ii). These institutions or persons include national governments, regulatory bodies, firms, privately or publicly funded research organizations, charitable non-profit organizations, wealthy individuals, private citizens that raise funds for research, and others. The RSSR summons, that these actors must actively promote and

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provide the conditions for the above responsibilities to be assumed and implemented, including “by establishing mechanisms for this purpose, such as ethics review boards” (16, b, ii).

1.4.4.2. Make sure that all employers of scientific researchers follow the ethical responsibilities defined in this section and section 2.1.3. above

In addition, the RSSR directs member states to “take all appropriate steps to urge all other employers of scientific researchers to follow” the responsibilities of researchers defined above, and the responsibilities of institutions or persons that fund, guide or govern research defined in this section (17).

1.4.4.3. Treat public funding of research and development as public investment, that is accountable to public opinion

Another ethical responsibility that the RSSR stipulates, is that “member states should treat public funding of research and development as a form of public investment”, whose rationales, justification and achievements are accountable to public opinion (6).

1.1.4.4. Ensure equal access to science and the knowledge derived from it

The RSSR clarifies in this regard, that “the scientific and technological knowledge and its potentialities be promptly geared to the benefit of all peoples” (23), and that “equal access to science and the knowledge derived from it” is an essential “social and ethical requirement for human development, [and] for realizing the full potential of scientific communities worldwide” (23).

1.1.4.5. Guarantee the health and safety of researchers and all persons likely to be affected by research and development activities

An additional point concerns the responsibility of governments and other institutions and people that fund, plan and guide research to guarantee “the health and safety of scientific researchers”, and “all other persons likely to be affected by the research and development activity in question”. For this purpose, member states are asked to comply with “all national regulations, and the international instruments concerned with the protection of workers in general”, so that safe keeping “from hostile or dangerous environments will be fully met” (32).

1.1.4.6. Take note of and address warnings of new hazards and risks of research and development activities

As part of this responsibility, the RSSR asks member states to “take due note of warnings of new hazards brought to their attention, in particular by the scientific researchers themselves, and act accordingly” (32). This also includes a commitment to “ensure that the working day and rest periods [of scientific work force] are of reasonable length, the latter to include annual and parental leave on full pay” (32).

1.1.5. Ethical issues and requirements of international science collaborations

In addition to the above requirements and responsibilities of researchers, governments and the funders of research, the RSSR lays down an additional set of ethical criteria for international research and international research collaborations. The text in the different subsections are verbatim quotations from the RSSR.

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1.1.5.1. The need to identify and address ethical challenges in international research collaborations

Establishing suitable means to address the ethics of science and of the use of scientific knowledge and its applications (20)

1.1.5.2. Ensure compliances with human rights and international research standards

Member States should endeavour to ensure that research and development undertaken, funded, or otherwise pursued in whole or in part in different States, is consistent with principles of conducting research in a responsible manner that respects human rights. In particular, for transnational research involving human subjects. (20)

Ensuring the protection of the human rights, fundamental freedoms and dignity of the human person, and the confidentiality of personal data. (18, e)

Protection of the health and safety of researchers, and all people and communities affected by research and its applications (32), as pointed out above, is a crucial dimension of this, as is the social and natural environmental environment in which research is carried out and applied. (see above)

1.1.5.3. Recognize and address regulatory diversity and ensure compliance with national regulations from multiple countries

Taking fully into account, in the adoption and application of this Recommendation, the great diversity of the laws, regulations and customs which, in different countries, determine the pattern and organization of research work and experimental development in science and technology, (Preamble d)

1.1.5.4. Conduct appropriate ethical review in both sponsor and host/recipient countries

Appropriate ethical review should be undertaken both in the host State(s) and the State(s) in which the funder is located, based on internationally agreed ethical frameworks.

This includes the need to make sure that mechanisms for this purpose, such as ethics review boards, and to ensure scientific researchers' protection from retribution. If these mechanisms are not in place, the RSSR requests to establish them (16, b, ii)

1.1.5.5. Adequate acknowledgement and crediting of Intellectual property rights

In the context of their intellectual property regime, ensuring that contributions to scientific knowledge are appropriately credited, and balancing between protection of intellectual property rights and the open access and sharing of knowledge, as well as ensuring the protection of sources and products of traditional knowledge.

1.1.5.6. Responsiveness to the needs of host countries

[International] research should be responsive to the needs of host countries, and the importance of it contributing to the alleviation of urgent global health problems should be recognized [and] integrate […] consultations with communities where the conduct of research may affect community members;" (16, a, vii)

1.1.5.7. Clear agreements for benefit sharing and access to research results

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When negotiating a research agreement and terms for collaboration, agreement on the benefits of the research and access to the results should be established with full participation of the communities concerned. 20, c

1.1.5.8. Capacity Building in international research partnerships

Member States should […] establish partnerships […] enabling developing countries to build up their capacity to participate in generating and sharing scientific knowledge, the related know-how and their benefits, including identifying and countering the effects of brain drain; 18, a

Persuaded that such governmental action can considerably assist in the creation of those conditions which encourage and assist indigenous capability to perform and use the results of research and development in an enhanced spirit of responsibility towards humankind and the environment" (Preamble, d).

1.1.5.9. Bilateral and multilateral agreements enabling developing countries to build capacity

This point follows from the above, and relates especially to international collaborations in the RSSR: and development of bilateral and multilateral agreements enabling developing countries to build up their capacity to participate in generating and sharing scientific knowledge, the related know-how and their benefits

1.1.6. Pathways to implement ethics in research and innovation

The next section provides an overview of recommended pathways in the RSSR through which the above mentioned ethical commitments, responsibilities and requirements can be implemented in research and innovation practice. The recommended actions below relate to both, national governments and inter-governmental bodies and initiatives. The text in the different sub-sections are verbatim quotations from the RSSR.

2.1.6.1. Develop machinery for the formulation and execution of adequate policies and regulation

[To face the] challenge [of misuse, dual use, irresponsible or dangerous use of science; see AC 9 above], member States should develop or devise machinery for the formulation and execution of adequate policies, that is to say, policies designed to avoid the possible dangers and fully realize and exploit the positive prospects inherent in such discoveries, technological developments and applications, (Preamble, b)

2.1.6.2. Develop adequate policies and regulation for protection of research objects, data, archives and infrastructures.

Member States should develop policies for the protection and preservation of research objects, scientific infrastructure and scientific archives, including in instances of conflict.

2.1.6.3. Creating an enhanced spirit of responsibility

Persuaded that such governmental action can considerably assist in the creation of those conditions which encourage and assist indigenous capability to perform and use the results of research and development in an enhanced spirit of responsibility towards humankind and the environment, (Preamble, d)

2.1.6.4. Ensure appropriate status of researchers

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Considering that research and development is carried out in exceptional working conditions and demands a highly responsible attitude on the part of the scientific researchers towards that work, towards their country and towards the international ideals and objectives of the United Nations, and that workers in this profession accordingly need an appropriate status, (Preamble, d)

2.1.6.5. Establish suitable means to address the ethics of science

Establishing suitable means to address the ethics of science and of the use of scientific knowledge and its applications, specifically through establishing, promoting and supporting independent, multidisciplinary and pluralist ethics committees in order to assess the relevant ethical, legal, scientific and social issues related to research projects involving human beings, to provide ethical advice on ethical questions in research and development, to assess scientific and technological developments and to foster debate, education and public awareness and engagement of ethics related to research and development; (5, d).

2.1.6.6. Ensure equal access to science education and scientific careers, without discrimination

Ensure that, without discrimination on the basis of race, colour, descent, sex, gender, sexual orientation, age, native language, religion, political or other opinion, national origin, ethnic origin, social origin, economic or social condition of birth, or disability, all citizens enjoy equal opportunities for the initial education and training needed to qualify for research and development careers, as well as ensuring that all citizens who succeed in so qualifying enjoy equal access to available employment in scientific research; (13, a)

Support individuals from underrepresented groups entering and developing careers in research and development. (24, c)

2.1.6.7. Take measures to ensure that benefits from research are shared with society, at national and international level

Ensuring equal access to science and the knowledge derived from it as not only a social and ethical requirement for human development, but also as essential for realizing the full potential of scientific communities worldwide; (18, b)

Health research collaborations: “So as to ensure the human right to health, Member States should take measures so that benefits resulting from any research and its applications are shared with society as a whole and within the international community, in particular with developing countries.” (22)

To ensure the human right to share in scientific advancement and its benefits, Member States should establish and facilitate mechanisms for collaborative open science and facilitate sharing of scientific knowledge while ensuring other rights are respected. (22)

2.1.6.8. Develop education and researcher awareness

Develop and use educational techniques for awakening and stimulating such personal qualities and habits of mind as: (i) the scientific method; (ii) intellectual integrity, sensitivity to conflict of interest, respect for ethical principles pertaining to research; (iii) the ability to review a problem or situation in perspective and in proportion, with all its human implications; (iv) skill in isolating the civic and ethical implications, in issues involving the search for new knowledge and which may at first sight seem to be of a technical nature only; (v) vigilance as to the probable and possible social and

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ecological consequences of research and development activities; (vi) willingness to communicate with others not only in scientific and technological circles but also outside those circles, which implies willingness to work in a team and in a multi-occupational context.

1.2. Linking the RSSR to the SDGs: connections, synergies and possible contributions

In the following sections we map aspects of the theme-specific analysis of the RSSR onto the SDGs. This involves engagement with the contents and aims of the SDGs at a more general level (across all SDGs, or groups of SDGs) and at the level of individual SDGs. The objective of the mapping process is to tease out and discuss the different ways in which specific terms of the RSSR can be linked to the SDGs, and be applied in science-based strategies to realise the SDGs. In identifying and describing the possible contributions of the RSSR to the SDGs, we aim to provide new perspectives and ideas that can help to improve the operationalization and implementation of the SDGs, and to make the realization of the SDGs more responsible, ethically robust, aligned with the needs of communities.

Because the RSSR provides guidance on science and technology (S&T) research, we focus especially on S&T-based solution pathways to achieve the SDGs. This includes a concern with the broader structural, societal and cultural factors that influence the ways in which research and S&T-based development is conducted and realised, and that enable or prevent access to scientific benefits and opportunities in a context of global inequalities and differences.

The discussion will be structured around four overarching themes, that emerge from our analysis in Part 1 above:

- Anticipation of longer-term implications, possible side effects and the dual use and misuse potential of science-based strategies to achieve SDGs
- Broad, open dialogue, commitment to truth and democratic decision making
- The ethical dimensions of international science and development
- Realizing equal access, inclusive science and justice

The ways in which these four themes are linked to aspects and sections of the RSSR discussed in Part 2.1. above are illustrated in the Table 1 below. Each theme will be broken down in a number of sub-themes that discuss and illustrate why and in which ways identified RSSR aspects matter and are relevant to the SDGs. Each sub-theme will be discussed in a different section, that follows a three-step structure: (1) a brief summary of the specific RSSR aspects that shall be mapped onto the SDGs; (2) a discussion of the possible role, value and significance of identified RSSR aspects to the SDGs at a more general level (e.g., across all or several SDGs); and (3) an exploration of the possible role, value and contribution of the discussed RSSR aspects to two or three specific SDGs (or SDG targets). We choose these SDGs as examples, to pursue a more detailed discussion of the relevance of specific terms of the RSSR This structure, will help to illustrate the broader significance of selected RSSR aspects to the SDGs at a more general level, and simultaneously allow to discuss the possible value and contribution to specific SDGs or SDG targets.

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Table 1. The ways in which these four themes are linked to Part 2.1.

	Anticipation of longer-term implications, possible side effects and potential for misuse and dual use	Broad, open dialogue, commitment to truth and democratic decision making	The ethical dimensions of international science and development	Realizing equal access, inclusion and justice
Relates to the following sections and themes in Part 2.1	2.1.1.2. Enhanced spirit of responsibility towards humankind and the environment	2.1.1.5. Autonomy and Freedom of Research; facilitate public debate and dialogue between science and society	2.1.1.9. research integrity and compliance with international principles	2.1.1.5. engagement and consultation of local communities, and negotiation of fair agreements on benefits of research
	2.1.1.4. Wellbeing of future generations	2.1.1.6. + 2.1.3.1. Speaking truth to power; ability and duty to warn of risk, hazards, etc	2.1.5.1. Identify challenges in international collaborations	2.1.1.4. Justice, fairness and inclusiveness
	2.1.3.2. Vigilance of social and ecological consequences of research and development	2.1.1.7. Accountability and disclosure of COI	2.1.5.2. Compliance with human rights and international standards	2.1.2.3. including local, traditional and indigenous communities in the deliberation around scientific
	2.1.3.4. Develop controls to minimize harm to subjects of research, as well as social environment	2.1.1.8. Science-based decision making, including on innovation decisions	2.1.5.3. Address regulatory diversity and ensure that researchers adhere to ethical requirements in different countries	2.1.3.6. Ensure knowledge sources are acknowledged and adequate benefit sharing
	2.1.4.5. Guarantee health and safety of all persons likely to be affected by science, etc	2.1.3.1. Search and defend truth, and protection from undue influences.	2.1.5.4. Ethical review in sponsor and host countries	2.1.4.3. treat public funding as form of public investment
	2.1.2.1. Dual use and misuse	2.1.3.3. Balance between furthering of interests and possibilities at national level, and the furthering of international objectives	2.1.5.5. Adequate acknowledgement and crediting of IPR	2.1.4.4. Ensure equal access to science and knowledge derived from it
	2.1.2.2. Illicit and socially problematic activities	2.1.4.6. Take note of and address warnings of hazards and risks	2.1.5.6. Responsiveness to needs of host countries	
			2.1.5.7. clear agreements for benefit sharing	
			2.1.2.3. Prevent scientific or economic exploitation of traditional, indigenous local	

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			and other knowledge sources	
			2.1.5.8. commitment to capacity building and indigenous development in developing countries	
			2.1.5.9. Fair bilateral and multilateral agreements	

2.2.1. Anticipation of longer term implications, possible side effects and the dual use and misuse potential of science-based strategies to achieve SDGs

The development of science and technology-based solutions to realise the SDGs is often based on the assumption that these applications will be overwhelmingly positive, and transform societies in beneficial ways. However, many S&T-based approaches that can help to achieve the SDGs can also create problematic consequences. These include, for example, possible short-to-long-term effects of technologies on human societies, vulnerable groups or eco-systems, dual use applications, or the misuse of technologies, including for illicit or "rogue" purposes.

The promissory potential of scientific research to realise the SDGs can prevent an engagement with these possible side effects, or other ethical issues. Moreover, in some instances, scientists and companies are likely to strategically exploit the potential of new technologies to achieve the SDGs, and to use the aspirations of the SDGs to mobilise public support and legitimise the use of controversial technology developments, while downplaying potential problems, risks and uncertainties.

The RSSR addresses these challenges, by recommending systematic scrutiny in order to anticipate the social and ecological implications of research, identify the potential for dual use and misuse applications, and prevent the scientific and economic

2.2.2.1 Anticipation of social and ecological implications and side effects of scientific innovation

As shown in Section 2.1 above, several passages of the RSSR refer to the need to examine and forecast the effects of scientific research on societies, social groups and individuals, including human research subjects. The RSSR requests in this regard, "an enhanced spirit of responsibility towards humankind and the environment" (RSSR Preamble d; discussed in Section 2.1.1.2 above), and the need to protect and enhance the "well-being of its citizens in the present and future generations" (RSSR 4; Section 2.1.1.4 above). In order to achieve this, the RSSR recommends "vigilance as to the probable and possible social and ecological consequences of research and development activities" (RSSR 14, d, v; Section 2.1.3.2 above), and the need to use "controls to minimize harm to each living subject of research, and to the environment", as well as "consultations with communities where the conduct of research may affect community members" (RSSR 16, a, vii; Section 2.1.3.4 above). The RSSR demands, furthermore, that governments and other institutions and individuals that fund, plan, guide or govern research, must guarantee not only the "health and safety of scientific researchers", but of "all other persons likely to be affected by the research and development activity in question" (RSSR 32; Section 2.1.4.5 above).

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Relevance to the SDGs

S&T driven innovation processes are central to the realization of the SDGs, and feature strongly in SDG 17, in the sections on Means of Implementation, where S&T innovation is defined as a cross-cutting objective to achieve all SDGs and many of its targets. The 2020 report "Unlocking Technology for the Global Goals" by the World Economic Forum (WEF) has provided an overview of more than 300 technology areas that are expected to contribute to the achievement of the 17 SDGs. These technologies encompass areas as diverse as (i) biotechnology, including crop biotech solutions, genome editing and synthetic biology, (ii) AI, robotics and the use of big data, including autonomous vehicles and drones, digital monitoring, and the Internet of Things, (iii) medical and health technologies, including new developments in predictive medicine and the remote monitoring of hard to reach communities, (iv) new types of farming technologies, that minimise the use of water, land and nutrient use, including nanotechnology and biosynthetic solutions for water purification and reclamation, (v) materials engineering approaches that develop advanced materials for clean energy production, as well as low emission chemicals and construction materials, and many other technology areas (World Economic Forum 2020).

Many of these technology developments, despite their potential to contribute to the SDGs, also raise concerns about their longer-term implications, possible risks, their likelihood to cause social and economic disruption, and likely adverse effects on the environment and ecosystems. This is why the systematic scrutinization and anticipation of the short-to-longer term social and environmental implications of these technologies, as demanded by the RSSR is crucial. We will now illustrate this point, by discussing technology solutions for individual SDGs.

Anticipation of social and societal implications: examples of specific SDGs

SDG 2: End hunger, achieve food security, promote sustainable agriculture

SDG2 aims to "double the agricultural productivity" (Target 2.3) and to "strengthen capacity for climate change, extreme weather, drought, (etc.)" (Target 2.4). A possible way to achieve these targets is through the use of advanced agricultural biotech solutions, which include the genetic modification (GM) of crops, microorganisms or livestock. While these technologies can improve food security, they can also have unplanned consequences on local farming practices and communities.

As previous controversies around the use of GM crops have shown, the introduction of GM products such as Monsanto's Bt cotton in India, has disrupted local farming systems and, at least in some contexts, put smaller farmers out of business (Kranthi and Davis Stone 2020).[7] While the causes of these problems have included contextual factors, such as low cotton prices, climatic conditions and risky credit systems (Gruere, Mehta-Bhatt and Sengupta 2008),[8] the public response, scientific controversies and social impact of GM crops in agriculture illustrate the need for the systematic assessment of the broader social implications, risks and unintended effects of advanced agricultural technologies, or other technologies that contribute to SDG2 and the SDGs more generally.

The use of agricultural robotics for harvest and process automation is another example. While automation of agricultural processes can increase yields and productivity, it raises critical questions about the short to long-term effects of these changes, in particular with regard to employment and

[7] Kranthi, K. R., & Stone, G. D. (2020). Long-term impacts of Bt cotton in India. *Nature plants*, *6*(3), 188-196.
[8] Gruère, G. P., Mehta-Bhatt, P., & Sengupta, D. (2008). Bt cotton and farmer suicides in India: Reviewing the evidence.

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the impact of the possible loss of livelihoods for manual laborers and their families. The impact of these changes is likely to be particularly high in developing countries, where a larger proportion of populations rely on agricultural work. In Sub-Saharan Africa and South Asia, for example, around 70% of the labour force works in the agricultural sector. Moreover, in many global regions more women than men are employed in agriculture (United Nations 2010).[9] This means, that in some contexts the automation of agriculture can increase gender inequalities, and deprive women, men and families from necessary income, at least if displaced workers are not reskilled and redeployed

SDG 9: Industry, Innovation and Infrastructures

As in agriculture, AI, robotics and automation are portrayed as promising pathways to increase efficiency, economic growth, and to achieve more sustainable, energy efficient forms of industrial production. The above-mentioned 2020 WEF Report, for example, lists "robotics for manufacturing and construction process automation", together with "automated, 3D printed buildings and infrastructure", and the use of drones and other autonomous vehicles "for remote goods delivery and remote infrastructure maintenance" as practical options to realise SDG9. The development and use of these technology applications to achieve SDG9 in different social and geographical settings, requires vigilance and a careful assessment of their probable and possible social consequences, that takes into account the cultural and material well-being of both present and future generations, as the RSSR has mentioned. Because the transformative impact of these technologies is likely to affect individuals, communities and industrial sectors in far-reaching ways, and because effects are likely to differ across global regions and social contexts, consultation with the workers, communities, firms and other stakeholders affected by these changes will be crucial. These are, of course, key directives of the RSSR.

There are many other SDGs where the use of technologies can create unintended, problematic effects on societies. SDG3 (health and wellbeing), SDG7 (clean energy), SDG8 (economic growth and employment), SDG10 (reduce inequalities within and among countries), SDG11 (Inclusive, safe and sustainable cities and human settlements), as well as SDG14 (conservation and sustainable use of oceans) are other examples, where the use of technologies can impact the well-being of people and communities in disadvantageous ways, and where the RSSR's demands for systematic anticipation, inclusive and participatory planning, open debate and community consultation are essential to make sure that possible problems are recognised.

Anticipation of environmental and ecological implications: examples of specific SDGs

A central directive of the RSSR, as mentioned above and in Section 2.1, is that researchers, funding bodies, firms and other organizations or individuals that conduct, guide, fund or govern research assume responsibility to recognise and minimize adverse effects and harm to ecosystems and the environment. This includes anticipation and monitoring of the ecological consequences of research and development activities, and the obligation to take note of and express warnings of possible environmental hazards and risks, and to follow up on these warnings through action.

Potential risks, adverse effects or negative effects of technology applications on the environment can in principle emerge across all SDGs. Negative effects resulting from high energy needs, for example, is a cross-cutting problem. While the development of renewable energy sources and more

[9] https://16dayscampaign.org/wp-content/uploads/2018/11/Gender-Issues-in-Agricultural-Labor-World-Bank-.pdf http://www.fao.org/3/i1638e/i1638e.pdf

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efficient energy use is a key aim in SDG7, the widely publicized role of ICT, AI and big data-based solutions to achieve SDGs is likely to increase global energy consumption, and can pose an additional burden to the environment. Energy use aside, possible problems for ecosystems and the environment can emerge from technology applications in most SDGs. Here are some examples.

SDG 3: Health

Target 3.3 of SDG 3 aims to end malaria and other mosquito-borne diseases. Ecological epidemiology approaches, such as the use of gene drives form a promising approach to eradicate the mosquito populations that transmit these diseases. However, the use of gene drives is also associated with substantial environmental risks. While gene drives aim to wipe out target populations, they can also reach other populations, disrupt ecosystems and cause harm to other species, including unintended extinction (Brossard et al., 2019).[10]

SDG 8: Inclusive economic growth

SDG8 aims to achieve "higher levels of economic productivity through diversification, technological upgrading and innovation" (Target 8.2). This relates closely to SDG 9's aim to "significantly raise industry's share of employment and gross domestic product, in line with national circumstances and double its share in least developed countries" (Target 9.4). Developments in industrial biotechnology are often cited as a promising pathway to achieve these targets, by replacing petrochemical production and contributing to a new era of industrialization that is cleaner, uses less energy, and is more sustainable.

However, industrial biotechnology also poses new challenges to the environment. For example, genetically modified organisms can escape into the wild, and upset the balance of ecosystems. Accidental release of biological agents can also create health risks to humans and other species by exposure to harmful agents (Chen and Renier 2018).[11] As the next example shows, in some cases the environmental benefits of industrial biotech applications may also be offset by forms of secondary pollution that result from the production of biological feedstocks.

SDG 13: Reduce Climate Change

The transition to industrial biotechnology and the bioeconomy is also seen as part of the solution to climate change. However, because the industrial biotechnology-based production of chemicals, plastics and bioenergy relies heavily on biological feedstocks, it can also cause problematic effects for the environment and ecosystems. For example, because the production of feedstocks compete with a growing demand for food and animal feed, the conversion of forests or grasslands to agricultural land is a possible consequence. However, land conversion can lead to significant releases of carbon to the atmosphere, which to some extent, can offset the environmental benefits associated with the shift towards a bioeconomy (OECD 2011).[12]

These are only examples. Many other technological solutions that aim to contribute to the SDGs (or specific SDG targets), pose significant and (in some cases) difficult to discern challenges and risks to ecological systems, including oceans. For these reasons, vigilance and systematic research into the

[10] Brossard, D., Belluck, P., Gould, F., & Wirz, C. D. (2019). Promises and perils of gene drives: Navigating the communication of complex, post-normal science. *Proceedings of the National Academy of Sciences*, *116*(16), 7692-7697.
[11] Chen, C., & Reniers, G. (2018). Risk assessment of processes and products in industrial biotechnology. In *Sustainability and Life Cycle Assessment in Industrial Biotechnology* (pp. 255-279). Springer, Cham.
[12] https://www.oecd.org/sti/emerging-tech/49024032.pdf

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possible environmental effects of new technological applications, as required by the RSSR is crucial in order to recognize and respond to identified challenges. As the RSSR has mentioned, such research needs to examine the "interconnections between various forms of life" and the "role and responsibility of human beings in the protection of the environment, the biosphere and biodiversity" (19c).

2.2.2.2. Anticipation of dual use and misuse

Dual use and misuse applications can cause significant problems to human societies and the natural environment, including for future generations. Dual use, as the RSSR points out, can involve the use of technology for warfare or attempts to achieve dominance of one country or group of people over another. It can also include applications for malicious purposes by terrorist or criminal organisations. The misuse of technology can also include illicit or grey area practices, such as the illegal sale of personal data, the selling of unverified medical treatments, or the use of digital data for unauthorised surveillance. Other examples, mentioned in the RSSR, are "biopiracy, illicit trafficking of organs, tissues, samples, genetic resources and genetic-related materials" (18, e). As the RSSR clarifies, dual use and misuse applications can cause significant violations of human rights, affect human dignity and restrict fundamental freedoms.

Relevance to the SDGs

Many of the technological solutions to achieve the SDGs can in principle also be used, modified or developed further for dual use and misuse purposes. For example, research and investments into AI, robotics, smart information systems and the Internet of Things, can pave the way for a broad range of potentially problematic applications that can be to the detriment of users, communities and the environment.

A 2020 publication in Nature Communications that explores the role of AI in achieving the SDGs, mentions that "AI can enable the accomplishment of 134 targets" across all the seventeen goals. However, it also states that if used wrongly, or in unethical or otherwise problematic ways, AI "may also inhibit 59 targets" (Vinuesa et al. 2020). Examples that illustrate the dual use and misuse potential of AI include the development of autonomous weapons, the manipulation of public opinion, the surfacing of new forms of surveillance, new mechanisms to control social behaviours, violations of the privacy of citizens and their data, and other applications that can undermine democratic principles and basic human rights (Vinuesa et al. 2020). Digital technologies, AI, robotics and the automation of services and social processes is just one technology area in which dual use and misuse applications can arise. Synthetic biology, gene editing, advances in biomedicine, ocean engineering and many other technologies that play a role in the realization of the SDGs are other examples in which wrong or problematic uses of technology can cause severe detrimental effects.

For these reasons, the systematic case-based assessment of a technology's dual use and misuse potential, as suggested by the RSSR is crucial. This must entail a careful analysis of the social, cultural and political factors that affect the ways in technologies are applied in practice and become embedded in institutions and specific domains of society.

This is especially important in the context of international technology transfer from higher income to developing countries. As SDG 17 stresses, the "transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms" (Target 17.7) is a central means to realise the SDGs. While technology transfer is meant to strengthen "technology

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and innovation capacity-building [..] for least developed countries" (Target 17.8), poorer countries often lack the regulatory policies and infrastructures that are necessary to supervise and control the use and development of emerging technologies. For example, while the EU and other developed countries have regulatory policies around dual use and misuse of technologies such as the EU Dual Use Regulation or also the General Data Protection Regulation, most least developing countries do not. This lack of regulatory oversight can increase the potential of misuse applications, including for illicit and socially problematic applications.

2.2.2. Broad public dialogue, commitment to truth and democratic decision making

Science and technology innovation is driven by powerful economic interests; of corporations, that seek to position new products in the market, and of governments, which compete with each other and seek to generate new economic opportunities and employment. This means that (i) the development of S&T-based solutions to realize the SDGs is characterized by significant conflicts of interests, and (ii) that decisions about which types of research to fund and which innovations to adopt take place in a contested and highly politicized environment. Some technologies, as mentioned above, can also serve as a source of political power, that can help governments or other stakeholders to gain legitimacy, mobilize public support, or also to influence public opinions and instill new forms of social and behavioural control.

For these reasons, the decision making, planning and implementation of policies and STI approaches for sustainable development greatly benefit from an environment that supports broad and open debate, public scrutiny, evidence-based assessments and democratic accountability. The RSSR recognizes and addresses these challenges by demanding the disclosure of "both perceived and actual conflicts of interests" of researchers and other stakeholders that fund, govern or profit from research (RSSR 10; Section 2.1.1.7 above). It also calls for a "vigorous and informed debate on the production and use of scientific knowledge" and encourages "dialogue between the scientific community and society" (RSSR 5c; Section 2.1.1.5 above). Freedom of speech and the ability of researchers and other actors in society to speak truth to power; to be safeguarded from "undue influences on […] independent judgment"; and to express themselves "freely and openly on the ethical, human, scientific, social or ecological value of certain projects" (RSSR 16a; Section 2.1.1.6 above), are other examples through which the RSSR seeks to address the challenges that arise from the competition and interest conflicts that surround research and innovation.

The RSSR also warns of the dangers of isolationist or more extreme forms of techno-nationalism, in which a commitment to truth and scientific integrity is endangered by populist politicians and movements, inward-looking nationalist policies, or authoritarian state structures. While the RSSR stresses the importance of national development and scientific capacity building around the world, and recommends that researchers constructively contribute to research and development in their home societies, it recommends finding a balance between researchers commitment "towards their country and towards" shared global challenges and "the international ideals and objectives of the United Nations" (RSSR 4; Section 2.1.3.3 above).

Relevance to the SDGs

The above points matter to the SDGs in several ways. First of all, conflicting interests and visions of how the SDGs can be achieved are at the center of the political processes and funding decisions through which Agenda 2030 is sought to be realized. Moreover, corruption and attempts to

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influence representations of the possible advantages of specific solutions to achieve sustainability, are a central problem for the realization of the SDGs. As a recent publication of the WEF has pointed out, the prevalence of corruption around the world forms a serious challenge to human development and has corrosive effects to the achievement of the SDGs (Rubio and Andvig 2019).[13] While SDG16 aims to "substantially reduce corruption and bribery in all forms" (Target 16.5), the WEF publication mentions that "corruption is intrinsically linked to all 17 SDGs, going well beyond institutions and financial flows to affect services and sectors we deal with every day", including in high income countries (Rubio and Andvig 2019).

However, corruption is only one problem that can affect the realization of the SDGs. Companies, industry groups, scientists and sometimes political stakeholders and NGOs have vested interests in and lobby for specific types of solutions, even though other pathways to achieve SDGs may be better suited, more effective, less risky or more affordable. These partialities can lead to misleading representations of the possible advantages of specific innovation directions and the exertion of undue influence. Considering that international development is characterized by substantial power inequalities, there is a clear danger that technological and corporate-driven solutions developed in high income countries will direct many of the strategies to implement Agenda 2030.

Conflicts of interest and incentives to steer innovation decisions into a specific direction exist in the context of many SDGs. Examples are decisions around "the development of new vaccines and medicines" (SDG3, Target 3b), investments in "renewable energies […] and advanced, cleaner fossil-fuel technology" (SDG7, Target 7a), efforts to "upgrade technological capacities of industrial sectors in all countries" (SDG9, Target 9.15), the building of "safe, affordable, accessible and sustainable transport systems (SDG11, Target 11.2), the, extraction, "management and sustainable use of natural resources" (SDG12, Target 12.2), the creation of "scientific capacity and transfer [of] marine technologies (SDG14, Target 14.a), and others.

Considering the high stakes nature of these decisions, the RSSR's demands for inclusive and democratic decision making, freedom of expression, inclusive public debate, evidence-based evaluation and transparent disclosure of interest conflicts – are critical requirements to ensure that innovation decisions on the SDGs take place in a more objective way, free from undue influence and made after full and fair assessment of different options.

2.2.3 International Research and Development Collaborations

International collaborations and research partnerships are central to the realization of the SDGs. For this reason, Agenda 2030 and the related Addis Ababa Action Agenda have promoted the establishing of new global networks and projects that bring together partners from universities, business and industry, governments, foundations as well as NGOs and other civil societal organizations. Cooperation with private sector stakeholders, which range from micro-enterprises to large-scale multi-national corporations, are seen as particularly important. Industry and business are also key players in the development of science and technology-based solutions to achieve the SDGs.

These collaborations take place in a context of global asymmetries of wealth, resources and scientific capacities as well as differences in cultural values, political systems and social and economic priorities. While global research and development partnerships can tackle global challenges and be advantageous for parties in both higher and lower income contexts, there is a

[13] https://www.weforum.org/agenda/2019/09/serious-about-sustainability-get-serious-about-corruption/

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potential for exploitation, unfair forms of benefit sharing, and "ethics dumping", where researchers or companies side-step regulatory regimes to conduct research abroad, which is prohibited in their home countries (Schroeder et al. 2019; Trust 2019).[14]

2.2.3.1. Compliance with national and international ethical principles, laws and human rights

The RSSR actively engages with the ethical dimensions and challenges of international research. It clarifies that research that is pursued or funded in different countries, must be "consistent with principles of conducting research in a responsible manner that respects human rights" (RSSR 20; Section 2.1.5.2 above), and complies with "ethical principles, as articulated in national and international regulations, law and other regulatory instruments" (RSSR 12; Section 2.1.1.9). As the RSSR points out, this requires an active engagement with the "great diversity of laws, regulations and customs, which in different countries determine the patterns and organization of research work and experimental development in science and technology" (RSSR Preamble d' Section 2.1.1.9). The RSSR also requires "appropriate ethical review" which "should should be undertaken both in the host State(s) and the State(s) in which the funder is located, based on internationally agreed ethical frameworks" (RSSR 16 b; Section 2.1.5.4).

Relevance to the SDGs

There is a long history of failed or problematic projects and collaborations in international development which are characterized by the misuse of unequal power relations, unfair agreements, the disregard of local needs, customs and communities, exploitation of vulnerable groups, failures to share benefits, negligence of ethical standards, etcetera (Dichter 2003; Fowler 2013; Schroeder et al. 2019).[15] Considering the important role of international research partnerships and cross-border technology transfer in strategies to achieve the SDGs, including through business-business and public-private sector collaborations, many of these problems can re-surface.

For this reason, a systematic engagement with the different ethical principles, laws and human rights that govern research and innovation processes in different countries is essential. This applies to international research conducted in the context of all SDGs. If research projects are conducted in countries with widely divergent regulatory and legal arrangements, it will be necessary that partners comply with international protocols and that research is reviewed and approved by appropriate authorities and ethical review committees in all countries involved.

It is important to point out, that specific SDGs involve different ethical issues and challenges that matter in the context of international research and development partnerships.

For example, SDG 3 (Health) raises distinctive issues about the involvement of human research subjects in medical research. These include, for example, absence of fully informed consent, exposure to unacceptable health risks, non-existing medical aftercare, lack of post-study access to treatments, the possibility of financial exploitation of research subjects, and other violations of human rights and dignity. SDG5 (Gender Equality) also has the potential to raise concerns when it comes to collaborative research between researchers and research participants in the Global South and Global North, where the former may be involved in research as mere participants or as a tick-

[14] https://www.globalcodeofconduct.org; https://link.springer.com/chapter/10.1007/978-3-030-15745-6_5

[15] Dichter, T. W. (2003). *Despite good intentions: Why development assistance to the third world has failed*. University of Massachusetts Press.; Fowler, A. (Ed.). (2013). *Striking a balance: A guide to enhancing the effectiveness of non-governmental organisations in international development*. Routledge.

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box exercise to show their involvement but unlikely to contribute as equal researchers to their counterparts.

International collaborations that materialize in the context of other SDGs, such as SDG 12 (sustainable consumption and production) or SDG 14 (sustainable use of oceans, seas and marine resources), on the other hand, raise issues regarding the use of natural resources. For example, there is considerable variation in the ways in which natural resources are governed across societies. In some countries, resources such as forests or water are governed only through weak frameworks, which creates environmental threats such as deforestation, biodiversity loss, fall in available water or the degradation of ecosystems (Shivakothi, Ullah and Pradham 2017).[16]

While both the RSSR and Agenda 2030 recognize and seek to prevent these issues, there exist various challenges to achieve this in practice. As Schroeder and colleagues (2019) point out, in many research projects and partnerships with low income countries, there is a lack of resources for environmental protection, and often incomplete information about potential risks or harm to the environment. These authors also note that the effective governance of natural resources and the environment in international collaborations can be affected by variations in customs, attitudes and norms regarding the environment.

Considering these challenges, and the often strong economic incentives to sidestep more stringent international norms, there is a clear danger that partners in international research and business collaborations will take advantage of international regulatory variation, also in research that is conducted in the name of the SDGs. This possibility increases in the case of emerging technologies, for which there is often still a lack of national or international regulatory frameworks, which strengthens the likelihood of adverse environmental and social effects in international partnerships.

The lack of regulation in specific research areas, adds weight to the role and responsibilities of research performing organizations and funders, which have to recognize and address regulatory gaps through self-regulation and ethical capacity building in research partnerships. While the RSSR provides guidance in this regard, in many technology areas self-governance and ethical capacity building within collaborative projects are uncharted territory, that require both human and financial resources, and are difficult to achieve (cf. Wahlberg et al. 2014).[17]

2.2.3.2.Fair access to research results and benefits among research partners and capacity building

In order to prevent exploitation in research and development partnerships and to ensure access to research results and fair sharing of benefits the RSSR demands that “when negotiating a research agreements and terms for collaboration, agreement on the benefits of the research and access to the results should be established with full participation of the communities concerned (RSSR 20; Section 2.1.5.7). It states furthermore, that “research should be responsive to the needs of host countries” (RSSR 16 a, Section 2.1.5.6). In partnerships with developing countries, this should include measures that enable “developing countries to build up their capacity to participate in generating and sharing scientific knowledge, the related know-how and their benefits” (18 a; Section 2.1.5.8).

[16] Shivakoti, G., Ullah, R., & Pradhan, U. (2017). Challenges of sustainable natural resources management in dynamic Asia. In *Redefining Diversity & Dynamics of Natural Resources Management in Asia, Volume 1* (pp. 3-12). Elsevier.
[17] Wahlberg, A., Rehmann-Sutter, C., Sleeboom-Faulkner, M., Lu, G., Döring, O., Cong, Y., ... & Rose, N. (2013). From global bioethics to ethical governance of biomedical research collaborations. *Social Science & Medicine*, *98*, 293-300.

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Relevance to the SDGs

The Agenda 2030 framework has triggered substantial amounts of public and private funding across the world. In some instances, scientists and companies are likely to strategically exploit the language and aspirations of the SDGs, for example to apply for funds, initiate new collaborations or to expand into new markets. In these and other projects, many of the "traditional" challenges of international research continue to exist.

In fact, any international project that takes place across global inequalities (including those that aim to achieve the SDGs with the sincerest of intentions), require careful consideration and action to ensure that the results and benefits of an international project will be available to all partners, including in resource poor countries. In the history of science there are many examples where researchers and businesses from wealthier countries conducted research in less well-off societies, with no or minimal input of local scientists, no transfer of knowledge and lack of capacity building (Dahdouh-Guebas et al. 2003; Minasny et al. 2020).[18]

International research that aims to achieve the SDGs is not exempt from these challenges. For example, SDG 8 (economic growth and employment) and SDG 9 (infrastructures and industrialization) rely in important respects on the international transfer of technologies and knowledge. In many countries, the financial and scientific means to achieve these aims independently are not existent, and capacities for joint research are also often limited. This creates dependencies and opens possibilities for exploitation and unequal forms of benefit sharing.

In SDG 9 in particular, there is a risk that multinational companies and scientists from high income countries will be the main profiteers from the building of new industries and infrastructures in low-income countries, benefiting from affordable labour, raw materials and potentially trapping these countries into increased debt. While these are long-existing forms of criticism (King and Schneider 1992; Escobar 1995), they have recently resurfaced especially with regard to China's development initiatives in Africa (Brautigam 2011).[19]

While both the RSSR and Agenda 2030 acknowledge and seek to avert these problems, the realization of international research that is based on an ethos of equality, shared access to research results and benefits, and a commitment to indigenous development and capacity building, requires vigilance, money and active work.

2.2.3.3. Respecting indigenous, traditional and local communities and knowledge sources

Another set of ethical concerns arises regarding the use of knowledge of indigenous, traditional and local communities and knowledge systems in international research. To prevent misuse by dominant actors, the RSSR requires that UNESCO member states must not only ensure "the protection of sources and products of traditional knowledge" (18 d; Section 2.1.5.5), but also that these knowledge sources must be "appropriately credited and compensated" (16 a; Section 2.1.3.6). The

[18] Dahdouh-Guebas, F., Ahimbisibwe, J., Van Moll, R., & Koedam, N. (2003). Neo-colonial science by the most industrialised upon the least developed countries in peer-reviewed publishing. *Scientometrics*, *56*(3), 329-343.; Minasny, B., Fiantis, D., Mulyanto, B., Sulaeman, Y., & Widyatmanti, W. (2020). Global soil science research collaboration in the 21st century: Time to end helicopter research. *Geoderma*, *373*, 114299.

[19] Brautigam, D. (2011). *The dragon's gift: the real story of China in Africa*. OUP Oxford. Escobar, A. (1995). *Encountering Development: The Making and Unmaking of the Third World.* Princeton: Princeton University Press.

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RSSR adds that, "if possible – benefits that results from these knowledge forms [must be] transferred back to their sources (16 a; Section 2.1.3.6).

Relevance to the SDGs

Local, traditional and indigenous knowledges form an important resource to many of the challenges that the SDGs seek to address. For example, indigenous and traditional knowledge systems are seen as integral to the realization of food security and sustainable agriculture (SDG 2), health and well-being (SDG3), the development of inclusive, de-colonized education curricula (SDG 4), sustainable use of oceans and waterways (SDG 14), responsible use of land and biodiversity (SDG 15), and others.[20] At the same time, local, traditional and indigenous voices and ways of seeing the world must be heard and understood to ensure that international research and development initiatives meet the needs of local communities and indigenous populations (Bicker, Sillitoe and Pottier 2004).[21]

Historically, many indigenous groups have suffered from a history of discrimination and exclusion. This makes indigenous people and other marginalized communities vulnerable to misuses of power, in both research and development. The previous section has already shown, that the RSSR and the SDGs both promote domestic forms of capacity building especially in lower income countries, and that this includes a concern with access to education, research and the benefits that arise from science and innovation processes, including for local communities and indigenous groups. However, a theme that has not yet been discussed are the ethical dimensions of the inclusion of local, traditional and indigenous communities and knowledges in research and knowledge production. Not only can local and indigenous knowledge make important contributions to science and development research, including the realization of the SDGs, but they can also be used for the generation of profit.

There are many examples, where the use of traditional knowledge for research and for-profit purposes has taken place without the knowledge or consent of communities, and without adequate forms of benefit sharing. Biopiracy, where indigenous knowledge about nature, or the medical properties of plants, is used by scientific researchers or companies without authorization or compensation, is a case in point (Robinson 2010).[22] For these reasons, indigenous people, local communities and governments in many countries, have demanded adequate protection for traditional and indigenous knowledge systems.

The RSSR reinforces these demands, by requiring that the sources and products of indigenous, traditional and other local knowledge systems are adequately protected, credited, compensated and that, if practically possible, benefits that result from international research, are transferred back and shared with indigenous groups or other local communities. Considering the large number of scientists, companies and projects through which the SDGs are tried to be achieved, and the financial and scientific incentives that underlie and shape interactions with indigenous and local communities around the world, the RSSR's demands to protect the interests of these groups are well-placed.

2.2.4. Realizing equal access, inclusive science and justice

[20] https://sustainabledevelopment.un.org/partnership/?p=31979
[21] Bicker, A., Sillitoe, P., & Pottier, J. (Eds.). (2004). *Development and local knowledge*. Routledge.
[22] Robinson, D. (2010). *Confronting biopiracy: challenges, cases and international debates*. Routledge.

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Unequal access to the benefits, outcomes and products of innovation processes is a problem, both at the national and international level. The RSSR has addressed these issues in several ways. It states that "member States should demonstrate and take action such that R&D is not carried out in isolation but as an explicit part of the nations' integrated effort to set up a society that will be more humane, just and inclusive" (RSSR 4; Section 2.1.1.4 above). It also summons that "the scientific and technological knowledge and its potentialities be promptly geared to the benefit of all peoples", and that "equal access to science and the knowledge derived from it" is an essential "social and ethical requirement for human development, [and] for realizing the full potential of scientific communities worldwide" (RSSR 23; Section 2.1.4.4).

Relevance to the SDGs

While Agenda 2030 aims to reduce inequalities and to broaden access to the opportunities that arise from research and innovation, considering the continued existence of inequalities between and within societies, fair and equal access to the outcomes and benefits of innovation processes remains a major challenge, also in the context of activities and projects that aim to realise the SDGs. This is especially the case for innovations that are costly for societies to implement, or that are affordable only to a smaller group of wealthy citizens, as is often the case with expensive medical technologies or treatments, which remain unavailable to many. Further the drive for open access/open science might prove challenging and unrealistic for researchers in the Global South when there may be expectation for their institutions to pay to have their research published. This might have an impact on the inclusion of indigenous knowledge that could be shared openly if barriers to open access were to be overcome.

In line with the objectives of SDG 3 (Health and Wellbeing), the RSSR mentions in this regard that in order to "ensure the human right to health, Member States should take measures so that benefits resulting from any research and its applications are shared with society as a whole and within the international community, in particular with developing countries" (RSSR 22; Section 2.1.1.4).

The profit-oriented character of private sector innovation contributes to the challenge of just and equal access, at least partly. While firms and multinational companies play a central role in research that seeks to achieve the SDGs, there remains a tension between a firm's motivation to address social problems and the requirement to generate revenue, pay its shareholders, and invest in new products (Hategan et al., 2020).[23] While some innovations, such as low-cost smart phones, can be catered to a large market, including in lower income countries, other innovations will continue to be provided to more wealthy consumer groups, which means that inclusive and just access to the benefits of innovation processes remains challenging.

Moreover, as mentioned further above, many of the 4th industrial revolution technologies that publications such as the 2020 WEF report "Unlocking Technology for the Global Goals" promote, can serve as a source of rising inequalities, if they are not adequately managed. The 2017 IMF World Economic Outlook states in this respect that half of the decline in labour income share between 1990 and 2015 in over 160 countries, can be traced back to IT technologies that enable automation

[23] Hategan, C. D., Sirghi, N., Curea-Pitorac, R. I., & Hategan, V. P. (2018). Doing well or doing good: The relationship between corporate social responsibility and profit in Romanian companies. *Sustainability*, *10*(4), 1041.

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and offshoring. This trend has led to job polarization in which wages for high-skill occupations has increased, but income for middle and low-skill employment has steadily decreased (IMF 2017).[24]

The UN 2020 report "Inequality in a Rapidly Changing World" sketches a similar picture of widening global inequality, stating that technological change is driving employment and income inequalities upwards. While 4th industrial revolution technologies and other technology developments have increased productivity in several areas of the global economy, the report states that:

[H]ighly skilled workers [are] benefiting the most from new technologies in many countries, but productivity gains brought about by such technologies are being captured by a small number of dominant companies. The presence of monopolistic or oligopolistic companies have distorted market competition and hindered the diffusion of new technologies within and among countries (UN 2020: 78).[25]

These broader economic trends illustrate the challenges that the realization of SDGs such as "reduce inequality within and among countries" (SDG 10), "sustainable industrialization" (SDG 9), and "full and productive employment and decent work for all" (SDG 8) face in practice. They also refer to some of the problems that technology-driven approaches to sustainable development can generate, aside to possible advantages. While the UN report concludes, that "the adverse consequences of recent technological progress are not inevitable", these challenges signal that a systematic and ongoing engagement with the RSSR's demands for research and innovation processes that aim to "set up a society that will be more humane, just and inclusive", and that gear the potential of science and technology research "to the benefit of all peoples", are more relevant than ever before.

1.3. Recommendations

Recommendation 1: Clear conceptualization of the RSSR's significance to the ethical governance of STI based approaches to the SDGs

The role and possible contributions of the RSSR to ethical governance of STI based approaches to the SDGs must be clearly defined. A first step into this direction will be a publication based on this chapter, that clearly defines the different areas of ethical reflection that the RSSR spells out, and why these matter to the realization of the SDG. The benefits of engaging with the ethical standards and requirements that the RSSR promotes must be clearly communicated, tailored to the needs and priorities of different types of stakeholders.

Recommendation 2: Awareness creation

In order to facilitate implementation of the RSSR, its significance and role in the context of science-based strategies to achieve the SDGs needs to be clearly communicated to scientists, industry innovators, government bodies, decision makers, NGOs, and other stakeholders. This can happen in various ways: (i) via the UN and Agenda 2030's online platforms, (ii) through collaboration with international scientific organizations that support the ethical standards set out in the RSSR, (iii) through targeted publications and a policy brief.

Recommendation 3: Collective development of case-specific pathways and procedures to enable implementation of the ethical dimensions, criteria and commitments that the RSSR defines

[24] https://www.imf.org/en/Publications/WEO/Issues/2017/04/04/world-economic-outlook-april-2017
[25] https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/01/World-Social-Report-2020-FullReport.pdf

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The collective development of case-specific pathways to facilitate the implementation of the RSSR's requirement to ethical governance, will be crucial to ensure that researchers can engage with the RSSR in practice, across diverse research and innovation contexts. This could be done through (i) the initiation of collaborations with funding agencies from different countries, with the aim to reflect on the integration of the RSSR's ethical commitments, standards and assessment procedures into national funding programs and policies; (ii) the organization of interactive workshops with stakeholder from varied backgrounds in different world regions, that discuss regional and context-specific challenges to the implementation of the RSSR and consider solutions on how to address these.

Recommendation 4: Educational programs, training and consultancy

The development of educational programs, training workshops and consultancy services to make sure that the content of the RSSR reaches decision makers and key research communities, such as universities, funding agencies, firms, NGOs and other stakeholders. Educational activities should offer clear guidance on pathways and methodologies through which aspects of the RSSR can be implemented in the context of research and development initiatives.

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Chapter 2: Gender Equality, Diversity and Inclusion

Chukwudi Paul Agu, Kingsley Utam, Cyril Eshareturi and Uduak Archibong

1. Introduction

This report sets out findings from the mapping exercise conducted as part of the objectives of subtask 6.1 of the RRING project. The document is structured into four sections: Section 1 gives a brief introduction to the report. Section 2 provides detail of the methodological approach underpinning the subtask; Section 3 presents analysis of the themes that emerged from the coding of the Recommendation on Science and Scientific Research document ([RSSR], UNESCO, *hereinafter referred to as the Recommendation*) and how they mapped to the 17 Sustainable Development Goals ([SDGs] United Nations); and section 4 presents recommendations in line with the objectives of the subtask.

2. Methodology

Aim: Alignment of RRI to advance the UN SDGs.

Objectives:

- Mapping the RSSR to the SDGs *(the content of this report)*
- Reflection on how RPOs can employ / engage with the SDGs *(addressed in a subsequent report)*

Mapping the RSSR to the SDGs is aimed at providing new perspectives, ideas and approaches that can help to improve the operationalization and implementation of each SDG, *by facilitating the integration of RRI (or RRI-like) practices in the SDGs, to make them more achievable.* The impact of the new perspectives, ideas and approaches in SDG operationalization and implementation will be aimed at the level of *national and international policy (making); future research and innovation projects (in industry and academia); as well as education and training of researchers, policy makers and other stakeholders.*

Documentary sources

Two documents were used for this task:

- 2017 Recommendation on Science and Scientific Researchers ([RSSR], UNESCO), and
- the United Nations 2030 Agenda for Sustainable Development with the 17 Sustainable Development Goals (SDGs).

Steps

The steps outlined below were followed in conducting the analysis, coding, and mapping of the RSSR to the SDGs:

i. **Coding: Close reading, theme-specific (gender equality, diversity, and inclusion) coding, and analysis of the RSSR**

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Open (inductive) coding of the RSSR was conducted by two researchers and aimed to extract all references in the Recommendation relating to gender equality, diversity, and inclusion which can be mapped/linked to the SDGs. 44 codes and 7 themes emerged from the analysis as shown in table 1 (see appendix 1). The coding exercise was completed independently by two researchers using CAQDAS (NVivo 12 Pro); any disparities in coding were resolved through discussion between the coders. The expert understanding of the concepts of gender equality, diversity and inclusion by the coders and clarity of the RSSR led to a high degree of consistency between the coders. The Coding/analysis of the RSSR was guided by the following questions:

- How are RRI ideas defined and operationalised in the RSSR? Which concepts, principles, recommended procedures, goals, etc. are mentioned?
- Which recommendations and implementation strategies does the RSSR provide, to support the adoption of RRI concepts in research and innovation practice? How useful are these to facilitate the integration of RRI (or RRI-like) aspects into the SDGs?
- What references does the RSSR make about the SDGs? And how does the RSSR define the role of RRI (or RRI-related) ideas with respect to the realization of SDGs, if at all?

ii. Mapping: Identifying connections, disconnections, and opportunities (i.e., possible connections) between the RSSR and the 17 SDGs

The mapping was essentially a qualitative assessment to identify where there are connections, disconnections and/or opportunities to create new connections between the components (themes) identified in the RSSR and the 17 SDGs or targets with specific reference to SDG 5 and targets – gender equality. The mapping exercise was completed by two reviewers (coders) using the questions outlined below as a guide with the aim of making recommendations towards integrating and (or) strengthening the links between the RSSR and the 17 SDGs and targets (see table 2, appendix 2).

- Which references to RRI and HR components does the 2030 Agenda / SDGs already make? For which purpose, and how are these ideas framed?
- Which of the RRI+HR components identified in the RSSR are not mentioned / addressed in the SDGs?
- In which ways can the identified RRI+HR components be used to better operationalise each SDG, so that they can be achieved and implemented in a more successful way?

iii. Generating recommendations: Reflective engagement with findings from steps 1 and 2

Table 3 (appendix 3) illustrates how the recommendations were formulated from the previous steps in addressing the key aims of the subtask (T6.1).

3. Theme-specific analysis of the RSSR

The following themes emerged from the coding exercise and they form the basis for the theme-specific analysis and presentation of findings in this section:

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- Support for scientific researchers *(in particular, early career researchers and those with caring responsibilities)* *[Paragraphs 27b, 32, 33, 34d, and 41 of the RSSR].*
- Equal access to education, training, employment, and career development opportunities *[Paragraphs 12, 13a, c, 14a, 24a, b, c, 28, 29, 30, and 34e of the RSSR].*
- Promoting ethical and responsible conduct of research and development *(including role/responsibility of science in society)* *[Paragraphs 4, 5d, f, 13d, 14b, c, d, 15, 16a-iv, a-vii, 19a, b, c, and 20 of the RSSR].*
- Open and equitable access to research and knowledge *(including "sharing of the whole scientific process")* *[Paragraphs 13e, 34e, 16a, 18c, 21, 27f, 36, and 18b of the RSSR].*
- Participatory research with communities / Indigenous people *[Paragraphs 16viii, 20a, b, c of the RSSR].*
- Protection and promotion of researchers' rights, and responsibilities *[Paragraphs 16, 18d, 32, 33, 38, 39a, b, 40, and 42 of the RSSR].*
- National and international cooperation and partnerships with state and non-state actors *[Paragraphs 18a, b, 22, and 44 of the RSSR].*

Support for scientific researchers *(in particular, early career researchers and those with caring responsibilities)*

The Recommendation *recommends* that *"Member States should ensure that scientific researchers are not subjected, merely by the nature of their work, to avoidable hardship (paragraph 27b); and that their working day and rest periods are of reasonable length, the latter to include annual and parental leave on full pay (paragraph 32); provision is made for them to enjoy adequate and equitable social security arrangements appropriate to their age, sex, family situation, state of health and to the nature of the work they perform (paragraph 33); appropriate appraisal systems are established (using international comparisons so as to adopt good practices) to ensure independent, transparent, gender-sensitive and tier-based performance evaluation that transparently accounts for family-care related interruptions of employment and encourage equitable treatment by means of incentives, so that the careers and research of those who take family related leave, including parental leave, are not negatively impacted as a result (paragraph 34d); the performance of research and development be not reduced to pure routine" (paragraph 41).*

Gender inequality and other forms of exclusion in science will not 'self-correct'. Actions from state and non-state actors are needed "*to remediate past inequalities and patterns of exclusion, actively encourage women and persons of other under-represented groups to consider careers in science, and to eliminate persistent biases against women and persons of other under-represented groups"* in science (paragraph 13c of the RSSR). In this regard, the Recommendation urged Member States to ensure that unpaid care is recognised and valued, and social security arrangements are provided for all scientific researchers. Unpaid care has a gender dimension – with women bearing a disproportionately large part of the burden. Thus, there is a need for gender equality, diversity, and inclusion consideration in developing career support and social security arrangements to support scientific researchers especially female researchers who are disproportionately affected by family-

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related care responsibilities and to encourage early career researchers. This is crucial in addressing the workforce shortage and low number of women in STEM fields.

Equal access to education, training, employment, and career development opportunities

The Recommendation *recommends* that Member States should ensure that *"all citizens enjoy equal opportunities for the initial education and training needed for, and equal access to available, employment in scientific research (paragraph 13a)* by *supporting all educational initiatives aimed at strengthening science, technology, engineering and mathematics (STEM) education, in schools and other formal and informal setting (paragraph 14a); encouraging mentorship for early career researchers (paragraph 34e); actively supporting women and girls, and individuals of other under-represented groups to consider careers in sciences; and eliminating all forms of bias or discrimination against women and persons of other under-represented groups in work environments and appraisal" (paragraph 13c);* The Recommendation also adds that *"Member States should encourage that facilities be provided so that scientific researchers enjoy lifelong opportunities for keeping themselves up to date in their own and in other scientific fields, by attendance at conferences, by free access to international databases and journals, libraries and other sources of information, and by participation in training" (paragraph 28).*

There is no robust science system without a competent, diverse, and sufficient scientific workforce. A diverse and robust STEM workforce is the cornerstone of advancement in scientific research, knowledge, and technological development. This is contingent on a diverse and inclusive STEM workforce pipeline which can only be achieved by ensuring equal access to initial STEM education in schools, other formal and non-formal settings for everyone. Eliminating gender inequality in access to education, training and other career development opportunities is fundamental to the attainment of most, if not all, the 17 SDGs.

Promoting ethical and responsible conduct, and application, of scientific research *(including role/responsibility of science in society)*

The Recommendation *recommends* that *"Member States should demonstrate and take action such that research and development is not carried on in isolation, but as an explicit part of the nations' integrated effort to set up a society that will be more humane, just and inclusive, for the protection and enhancement of the cultural and material well-being of its citizens in the present and future generations, and to further the United Nations ideals and internationally-agreed objectives, while giving sufficient place to science per se" (paragraph 4).* It also *recommends that* Member States should *"establish suitable means to address the ethics of science and of the use of scientific knowledge and its applications, through establishing, promoting and supporting independent, multidisciplinary and pluralist ethics committees in order to assess the relevant ethical, legal, scientific and social issues related to research projects involving human beings, to provide ethical advice on ethical questions in research and development, to assess scientific and technological developments and to foster debate, education and public awareness and engagement of ethics related to research and development; (paragraph 5d); support educational initiatives designed to incorporate or develop in each domain's curricula and courses the ethical dimensions of science and of research (paragraph 14c); and stimulate, through education, the professional ethics of researchers including their intellectual integrity, sensitivity to conflict of interest and vigilance as to the probable*

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and possible social and ecological consequences of research and development activities (paragraphs14d ii and v).

Ethics is one of the key pillars of responsible research and innovation (RRI). Research ethics committees (RECs) play a critical role in ensuring the ethical soundness of research projects across various scientific domains. They assess research protocols or proposals on ethical considerations and make crucial decisions in line with recognised ethical principles in national and/or international guidelines or frameworks on research ethics. Some of the ethical principles focuses on benefit and harm; consent; equality, justice, and equity; non-discrimination and non-stigmatisation, and sharing of benefits (UNESCO, 2005). The extent to which the decisions made by RECs can affect scientific research practices depends on, amongst other factors, the legal context of operation and the interpretation of these ethical principles by the constituent members (EIWH, 2003; Schuppli and Fraser, 2007). The latter will be influenced by their values, lived and learnt experiences, research background and discourses (EIWH, 2003). Thus, to provide a basis for fairer decisions and ensure that all ethical aspects of research projects are reviewed in line with agreed ethical principles, several national and international guidelines on ethics including the RSSR recommend that the composition of RECs should be multidisciplinary, multisectoral, and gender balanced (Moerman et al., 2007; WHO, 2009; UNESCO, 2018). Some national ethics guidelines have gone further to recommend for RECs to integrate gender equality, diversity, and inclusion dimensions in their composition and review procedures to effectively address gender-based ethical issues in research projects (Moerman et al., 2007). The lack of integration of gender equality, diversity, and inclusion principles in the composition and review procedures of RECs has serious ethical and research consequences. This includes missed opportunities by RECs to flag exploitative research designs and practices and probable cases of ethics dumping which amongst other problems exacerbates gendered vulnerabilities and areas of intersectionality.

Participatory research with communities / Indigenous peoples

The Recommendation *recommends* that Member States should *"ensure that knowledge derived from sources, including traditional, indigenous, local, and other knowledge sources, is appropriately credited, acknowledged, and compensated as well as to ensure that the resulting knowledge is transferred back to those sources (paragraph 16a Viii), and ensure that when negotiating a research agreement and terms for collaboration, agreement on the benefits of the research and access to the results is established with full participation of the communities concerned" (paragraph 20c).*

The full participation of communities and Indigenous peoples in scientific research is integral to establishing the connection between science and society. To redress the power imbalance in research with communities and Indigenous peoples, the practice of participatory research has been extensively recommended in the literature and by international organisations including the World Health Organisation (Dadich, Moore & Eapen, 2019). Participatory research takes different forms and scope and is determined by rules, norms, and perceptions, in addition to the inherent capabilities of potential participants. However, participation has a gender dimension; thus, full participation of communities and Indigenous peoples in research may be impeded by social, cultural and, or legal constraints which limits or excludes women from participating in decisions and projects that affects them. Recognising the role of, and ensuring that gender equality, diversity and inclusion

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dimensions are integrated in participatory research allows for those that are seldom seen, and heard in research including, women, indigenous communities, and people from other underrepresented groups, to share in the scientific process, output, and outcomes. It also provides a pathway to tackling existing inequalities and building local trust in science, and scientific researchers. Given the history of mistrust between researchers and Indigenous communities, the participatory research process has been described as an issue of ethical principle (Kral, 2018). Participatory research should be predicated on the principle of social justice and mutuality - a relationship which seeks democratic involvement, empowerment, local knowledge and expertise, the co-creation of meanings and understandings and the mutual sharing of benefits (Kral, 2018).

Protection and promotion of researchers' rights and responsibilities

The Recommendation *recommends* that *"Member States should establish mechanisms and take all appropriate measures aimed to ensure the fullest exercise, respect, protection and promotion of the rights and responsibilities of scientific researchers (paragraph 16) including appropriate legal protection of their intellectual property, and in particular the protection afforded by patent and copyright law (paragraph 37), right of association with professional bodies and labour unions (paragraph 42), right to publish or communicate results (paragraph 38), and enjoy the degree of autonomy appropriate to their task and to the advancement of science and technology" (paragraph 10). And in cases where restrictions are placed on scientific researchers' right to publish or communicate results, that they are strictly minimised, consistent with public interest, employers', and other researchers' rights, and properly communicated as clearly as possible in writing in the terms and conditions of their employment (paragraph 38a).*

Protecting the rights and responsibilities of scientific researchers is fundamental to scientific advancement and in making science work for societal development. The Recommendation sets out some of the rights and responsibilities of scientific researchers including rights to free movement, association, expression, and communication, and equal access to data and information. These responsibilities were also covered in the European charter and code of conduct for the recruitment of researchers (European Commission, 2005). However, these rights and responsibilities can be threatened by attacks on the role and values of science in society through cases of discrimination, harassment or mobility restrictions against individual researchers or groups of people based on their gender, other diversity dimensions such as race, ethnicity, caste, disability, age, language, nationality or citizenship status, religion, political perspective, sex, or marital status, and areas of intersectionality. Intersectionality recognises that multiple identities (including gender) interact to perpetuate or exacerbate inequalities which can affect the extent to which individual scientific researchers, especially women, enjoy these rights and carry out their responsibilities. The rights can be protected through the enactment of enabling laws as well as the adoption of a combination of non-traditional legal instruments comprising norms, codes of conduct, and regulatory standards developed by professional associations (Marchant and Pope, 2009).

National and international cooperation and partnerships with state and non-state actors *(between developed and developing countries)*

The Recommendation *recommends that "Member States should strive to extend and complement their own action in respect of this Recommendation, by cooperating with all national and*

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international organisations whose activities fall within the scope and objectives of this Recommendation, in particular National Commissions for UNESCO; international organisations; organisations representing science and technology educators; employers generally; learned societies, professional associations and trade unions of scientific researchers; associations of science writers; women in science associations; youth and student organisations" (paragraph 44).

With increasing social and economic interdependence among countries of the world, societal challenges ranging from climate change to health issues, and to mass migration, have become more transnational in scope beyond the capacity of Member States to address alone. Thus, there is a need to ensure equal access to scientific knowledge and evidence produced outside national borders through broader international cooperation and partnerships. Integrating gender equality, diversity and inclusion dimensions in national and international partnerships and corporations improves the quality and effectiveness of interventions and ensures that they do not aggravate or perpetuate existing inequalities when implemented. Working with both national and international women in science associations, for instance, allows Member States to leverage their lived experience of intersectional inequalities in developing issue-specific and evidence-informed interventions.

Scientific research partnership between developed and developing countries is critical to the reduction of inequalities among nations and enhancing sustainable development across regions of the world. This involves encouraging relationships and collaboration between research communities in both developed and developing countries; encouraging the building of local research capacities of developing countries for meaningful participation in the generation and sharing of scientific knowledge and know-how; equitable sharing of scientific knowledge among partners and building of research institution including the provision of necessary enablement for the conduct of research in developing countries. Such partnerships should prioritise the building of both human capacities and infrastructural facilities for the conduct of meaningful research especially in developing countries. This should be complemented by the design of adequate remuneration and other conditions of employment for researchers. Such healthy partnerships will ensure that practising and prospective scientific researchers do not seek greener pastures in developed countries where the employment conditions of researchers are more attractive. This could also encourage young researchers who seek higher education overseas to return and contribute to development of their home countries thus reducing rate of brain drain from developing to developed countries.

3.1. Linking the RSSR to the 17 SDGs: Connections, disconnections, and opportunities

Support for scientific researchers *(in particular, early career researchers and those with caring responsibilities)*

The Recommendation recognises the need to account for, and value, unpaid care. This plays a critical role in improving the recruitment and retention of female early career researchers and helps in addressing the persisting issue of gender inequality in the STEM sector. Evidence shows that women (even those in full-time employment) are disproportionately burdened by family-care related responsibilities (ILO, 2018). "The unequal, and often large, amount of unpaid care work

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carried out mainly by women and girls from socially disadvantaged groups constrains both their availability to undertake paid employment and the type and quality of jobs they can access" (Dugarova, 2020; ILO, 2018, p.10). In terms of the amount of time devoted to unpaid care, women spend 3.2 times the hours men spend in unpaid care (Charmes, 2019). The recommendation also suggested possible strategies that Member States can adopt to support scientific researchers taking into consideration the burden of unpaid care. This includes *ensuring that their working day and rest periods are of reasonable length, the latter to include annual and parental leave on full pay,* and that provision is made for them to enjoy *adequate and equitable social security arrangements appropriate to their age, sex, family situation, state of health and to the nature of the work they perform* (UNESCO, 2018, p.18). SDG 5.4 also emphasised the need to account for, and value, unpaid care. The implementation of the related provisions in the recommendation will play a crucial role in achieving, amongst other SDGs, SDG 5 (target 5.4) which focuses on gender equality and the empowerment of women and girls. This can be achieved through a targeted and multi-faceted institutional approach focusing on female early career researchers and by ensuring that past (persistent) inequalities and other forms of disadvantages are addressed.

Connections

Focal goals - SDG 1, 4, 5, 8, 10, 16.

Within each of these goals, this theme was mapped to the following targets:

SDG 1.1, 1.2, 1.3, 1b, 4a, 5.1, 5.4, 5.5, 5c, 8.5, 10.1, 10.2,10.3, 10.4, 16.7.

Equal access to education, training, employment, and career development opportunities

The Recommendation recognises the role of education in developing scientific research, knowledge and technology. It shows support for the education and career advancement of scientific researchers irrespective of personal identities. It recommends that Member States should ensure that all citizens enjoy equal opportunities for the initial education and training needed to qualify for research and development careers without discrimination based on characteristics such as race, colour, descent, sex, gender, sexual orientation, age, native language, religion, disability, political or other opinion, ethnic origin, and areas of intersectionality. It also recommends that all citizens who successfully qualify from the required education and training should enjoy equal access to available employment opportunities in scientific research, training and career development.

Connections

Focal goals - SDG 1, 4, 5, 8, 10, 16.

Within each of these goals, this theme was mapped to the following targets:

SDG 1.4, 4.1, 4.2, 4.3, 4.4, 4.5, 4.7, 4a, 5.1, 5.4, 5.5, 5.6, 5c, 8.6

Education is vital for achieving the sustainable development goals. It is a standalone SDG (SDG 4 – quality education) and an enabler cum accelerator for the other 16 SDGs. Existing evidence highlights that about "97 million girls and 102 million boys of secondary school age" are out of school, and for many of these children, "just being at school does not mean they are learning" (UNICEF, 2020, p.3). Other estimates reveal that by 2030, about 880 million children in low- and

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middle-income countries will fail to develop the skills required to be successful in the workforce and, by implication, also not be on track of "developing the skills they need to successfully transition to adulthood" (GBC & Education Commission, 2019; UNICEF, 2020, p.3). Research also shows that "harmful practices such as early marriage, gender-based violence, as well as discriminatory education laws and policies still prevent millions of girls from enrolling and completing their respective education" (UNESCO, 2019). Hence, the recommendation recognises the need to strengthen STEM education in not only schools and other formal settings but also in informal settings. It also recognises the need to provide support for individuals from underrepresented groups entering and developing careers in research and development.

Education in informal settings is particularly important given its unique position to provide opportunities for STEM skills and development to vulnerable and marginalised populations for whom the formal education sector has failed or underserved (Kwauk et al., 2018). For most marginalised and vulnerable women and girls whose learning opportunities and life outcomes are threatened by early marriage and pregnancy, poverty, and gender-based discrimination, evidence suggests that access to quality learning opportunities in "STEM subjects and developing the skills that STEM learning cultivates that are applicable throughout life such as thinking laterally, problem solving and innovating, will be crucial for their education, health, voice and empowerment" (UNICEF, 2020, p.3).

Equal access to education plays a vital role in the attainment of gender equality. Imbibing the principles of gender equality, diversity and inclusion in young people at the early stages of life through education provides them with an alternative perspective to gender socialisation as opposed to the traditional gender roles, norms and/or rights which further entrenches gender inequalities across in society (Jha and Shah 2020).

Consequently, the implementation of the provisions in the RSSR which encourages Member States to ensure equal access to education and employment opportunities for all citizens in science and scientific research will contribute towards achieving the SDGs 4 and 5. This will require Member States to develop a multi-pronged approach that seeks to close the gender gap at all levels of the educational cycle as well access to professional careers in science and technology-related disciplines.

Promoting ethical and responsible conduct of research and development *(including role/responsibility of science in society)*

The Recommendation *recommends* that the conduct of scientific research and its application conform with ethical principles particularly relating to the respect for human right and be aligned to societal ideals. It recommends that science should contribute to the advancement of mankind and be used in the acquisition of knowledge, in addressing the root causes and impacts of conflict, and in achieving sustainable development. It is common knowledge that peace and unity are the bedrocks of sustainable development, hence conducting research and development in an ethical and responsible manner is central to the realisation of all the sustainable development goals.

Connections

Focal goals - SDG 3, 4, 5, 7, 12, 13, 14, 17

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Within each of these goals, this theme was mapped to the following targets:

SDG 3b, 4.7, 7a, 12a, 13.3, 14.3, 14a, 17.6, 17.16

The recommendation recognises that effective scientific research and knowledge is needed for addressing the global challenges as articulated in the SDGs. However, it also acknowledges that scientific research can cause harm to research participants or host communities and create wider social and environmental problems. Thus, it recommends for Member States to put in place measures or develop strategies that will ensure ethical and responsible conduct of scientific research, use and/or application of scientific knowledge. Some of the measures suggested in the recommendation include the need for Nation States to set up *independent, multisectoral, multidisciplinary and pluralist ethics committees* that can effectively assess the ethical dimensions of, and issues related to, research projects and foster a robust ethical climate for scientific research (UNESCO, 2018, p.8). It also encouraged scientific researchers *to express themselves freely and openly on the ethical, human, scientific, social or ecological value of certain projects, and in those instances where the development of science and technology undermine human welfare, dignity and human rights or is "dual use", they have the right to withdraw from those projects if their conscience so dictates and the right and responsibility to express themselves freely on and to report these concerns* (UNESCO, 2018, p.13)

Advancement in science and technology has been very instrumental to improvements in health care services across various health systems and more recently in the speedy development of vaccines to combat the COVID-19 pandemic. Also, it plays a critical in role in the global campaign for health equity and ensuring that no one is left behind (SDG 3) especially for vulnerable and marginalised populations. For example, the advancement in genetic engineering (manipulation of DNA or RNA) paved way for the rapid development of genome testing and editing technologies which have shown immense utility in its application such as in improving diagnosis and the development of targeted therapies (precision medicine) for various human diseases including mental and neurological disorders, cancer, diabetes, sickle cell anaemia, and cardiovascular disease (Semiz & Aka, 2019). However, there have been several reviews about the ethical, legal and social issues associated with the use and/or application of genome editing technologies particularly around human genome editing for reproductive purposes (NIH, 2017; Semiz & Aka, 2019). There is also the concern that due to the high cost of the genome editing technologies, related services "will only be accessible to the wealthy and will increase existing disparities in access to health care and other interventions" (NIH, 2017). Many researchers also worry that "taken to its extreme, germline editing could create classes of individuals defined by the quality of their engineered genome" and further perpetuate inequities as result (NIH, 2017).

Promoting ethical and responsible conduct of scientific research ensures that scientific discoveries and related technological developments and applications are not used against societal interests in other to develop weapons of warfare or for purposes of the exploitation of one nation by another. Existing evidence shows that women, girls, and children are disproportionately affected during and in post-conflict situations (GSDRC, 2015). Research also shows that violent conflicts and wars further widens forms of inequalities beyond sexual and gender-based violence to encompass other gender related effects of violent conflicts including widowhood, indirect impact on health, migration and

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displacement, asset and income losses, changes in marriage and fertility, political and civic participation, education and children's human capital (Buvinic, Das Gupta, Casabonne, & Verwimp, 2013).

Consequently, the implementation of the provisions in the RSSR which encourages Member States to ensure equal access to education and employment opportunities for all citizens in science and scientific research will contribute towards achieving the SDGs 3 and 5.

Open and equitable access to research and knowledge *(including "sharing of the whole scientific process")*

The provision of open and equitable access of scientific research and knowledge is instrumental to the attainment of most, if not all, of the SDGs. This is because scientific knowledge is fundamental to the attainment of a broad range of sustainable development activities including the development of scientific and technological know-how, the building of the knowledge economy, innovation, education, health, the environment, empowerment of researchers, poverty alleviation, food production and bridging the inequalities between the developing and developed countries. This mapping has revealed that open access is directly or indirectly instrumental to the attainment of all the SDGs as the world today relies on knowledge sharing for sustainable development due to globalization, internationalisation and the increased inter-dependence among countries.

Connections: Focal goals - SDG 3, 5, 10, 12, 13, 15

Variance in the level generation and exchange of knowledge across different regions and countries of the world contributes to global inequalities (Schöpfel, 2017). This is because the production of knowledge requires substantial financial and technological resources which is most of the time inadequate or completely lacking in developing countries (Czerniewicz, 2013). The recommendation recognises the need to improve access to scientific knowledge and recommends for equitable and open access to scientific research processes and outcomes *including access to scientific literature, data and contents through the removal of barriers to publishing, sharing and archiving of scientific outputs; the establishment of mechanisms for collaborative open science and partnerships freely associating scientific communities of developed and developing countries to meet the needs of all countries* (UNESCO, 2018). Also, the recommendation recognises the need to ensure that such access and partnerships respect intellectual property rights and national regulations. The implementing the related provisions in the recommendation could enhance the knowledge generation capacity of developing countries specifically help in the realisation of the SDGs 3 (Good health and wellbeing), 11 (Sustainable cities and communities), and 13 (Climate action).

Participatory research with communities / Indigenous people

Participatory research has often been suggested as a solution to the scepticism held by many communities and indigenous populations of research projects and scientific researchers. This stems from a history of unethical research projects conducted on indigenous people and communities and/or the adoption of research cultures or inappropriate research practices that often served to reinforce the "politics of colonial control" and not the concerns or needs of the research participants and/or host communities (Cochran et al., 2008). Participatory research provides the basis for successful research collaboration and partnerships between researchers and indigenous

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communities, and creates a pathway for co-creation of knowledge, sustainable and inclusive solutions to societal challenges. Such collaborations and partnerships allow researchers access to host communities, indigenous knowledge, skills, and local capacities taking into full consideration traditional cultures and values (Cochran et al., 2008; Popkin, 2016). It is therefore crucial for researchers to ensure that collaborations and partnerships are built on mutual sharing of responsibilities, knowledge, and benefits. Depending on the nature of the research and its objectives, such partnerships could result in a range of positive impacts for the communities concerned such as improvements in health, environment, sanitation, agriculture and food, climate, poverty reduction, gender equality, diversity, and inclusion.

Connections: Focal goals - SDG 1, 2, 3, 5, 10, 11, 13, 14, 15, 16

Existing evidence suggests that one of the key challenges to research collaborations and partnerships with communities is how to distribute the benefits of the research findings especially when external needs or interests contrast with the needs of host communities and/or research participants (Cochran et al, 2008). The recommendation recognises this challenge and recommends that agreement on the benefits of research and access to the results should be established early on in research contract negotiations and decisions on terms of collaboration with the full participation of host communities especially for transnational research projects. Ensuring participatory scientific research with communities and indigenous populations in the manner advocated in the recommendation could directly contribute towards achieving (but not limited to) SDG 1 (End poverty in all its forms everywhere), SDG 2 (End hunger, achieve food security and improved nutrition and promote sustainable agriculture) and SDG 3 (Ensure healthy lives and promote wellbeing for all at all ages), SDG 5 (Gender equality), SDG 10 (Reduced inequalities), SDG 11 (Sustainable cities and communities) and SDG 16 (Peace, justice and strong institutions).

Protection and promotion of researchers' rights and responsibilities

The Recommendation *recommends* that Member States should take action to protect the rights of scientific researchers. Some of the key areas include legal protection of their intellectual property (patents and copy right laws) rights, right to disseminate research outcomes, right to receive constructive feedback from peers locally and internationally, right to enjoy benefits of research, and the right to join different forms of professional and labour unions. These recommendations are in consonance with the SDGs listed below. These SDGs aim to promote *"universal respect for human rights and human dignity, the rule of law, justice, equality and non-discrimination; respect for race, ethnicity and cultural diversity; equal opportunity and allowing for the full realization of human potential and contributing to shared prosperity"* (*Paragraph 8 of the Declaration adopted by the United Nations General Assembly in September 2015*). They also target the rights of individuals to acquire knowledge and skills to contribute to sustainable development as well as the right to enjoy good health and wellbeing at all ages.

Connections

Focal goals - SDG 3, 4, 5, 8, 10, 16

Within each of these goals, this theme was mapped to the following targets:

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SDG 3.9, 4.7, 5.1, 5.2, 5.4, 5.5, 5c, 8.8, 10.3, 16b

The recommendation recognises the need to protect the rights and responsibilities of scientific researchers, thus, encouraged Member States to ensure that the rights of both men and women are protected in the conduct of their research and that they have equal access to all the privileges due to them. This has broader implications for the advancement of gender equality in terms of equal access to opportunities for skill acquisition and empowerment of both women and men to realise their full potentials. If implemented as intended, this recommendation will effectively contribute to the achievement of the SDG 5 "achieve gender equality and empower all women and girls".

National and international cooperation and partnerships with state and non-state actors

The Recommendation *recommends* that Member States facilitate partnerships and associations between local scientific researchers and the international community of researchers across developed and developing countries to "enhance their progress respecting national regulation, including cultural and scientific cooperation and development of bilateral and multilateral agreements enabling developing countries to build up their capacity to participate in generating and sharing scientific knowledge, the related know-how and their benefits, including identifying and countering the effects of brain drain". It also recommends that Member States should ensure equal access to science and the knowledge derived from it as not only a social and ethical requirement for human development, but also as essential for realizing the full potential of scientific communities worldwide; and that the benefit from research and its application be shared with the entire societies across developed and developing countries. These recommendations are in line with and contribute to the realisation of the SDGs listed below by encouraging mutually beneficial collaborations in scientific research to enhance sustainable development.

Connections

Focal goals - SDG 9, 10, 12, 16, 17

Within each of these goals, this theme was mapped to the following targets:

SDG 10.7, 12A, 16.8, 17.6, 17.9, 17.16, 17.17

The recommendation recognises that scientific research collaborations between developed and developing countries could help in bridging the knowledge gap between rich and poor countries. The research collaboration process enables the building or enhancement of local scientific research capacities in the developing countries and consequently increase innovation in science and technology. Improvements in science and technology have considerable effects on the development of different sectors such as economy, agriculture, healthcare, education, human capital and enhanced infrastructural facilities. If implemented as intended, the related recommendations can directly enhance the actualisation of the SDG 9 – build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation, and SDG 10 – reduce inequality within and among countries.

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4. Recommendations

Support for scientific researchers *(in particular, early career researchers and those with caring responsibilities)*

Member States should develop a bundle of intervention to support scientific researchers, targeting female researchers with caring responsibilities and early career researchers. The bundle is essentially a set of evidence-informed interventions (policies and practices), which when delivered together have proven to be more effective and lead to better outcomes than single interventions. This recommendation is contingent upon conducting extensive research into what works, where, how, for whom and in what context, regarding each of the interventions/components that will form part of the bundle; and ensuring that gender equality, diversity and inclusion dimensions are integrated in the design and implementation of the bundle.

This recommendation supports the section/paragraph(s) in the RSSR that encourages Member States to *design and establish appropriate performance appraisal systems for independent, transparent, gender-sensitive and tier-based performance evaluation for scientific researchers in their employ* (UNESCO, 2018, p.18).

Equal access to education, training, employment, and career development opportunities

Member States should adopt an intersectional lens in developing and implementing educational interventions in schools, other formal and non-formal settings – one that recognises how multiple (and marginalised) identities intersect in perpetuating disadvantages / discriminatory practices against different groups of people in society and pose access barriers to education. This approach will help in identifying the multiple barriers to access to education for women and girls, and other underrepresented groups, and in designing issue-specific and context-relevant interventions. It also accounts for context and lived experience – as important and valuable of sources of knowledge.

Member States should take action to ensure that qualified candidates from underrepresented groups have access to careers in research and all sectors of the economy. This recommendation can be implemented through designing affirmative action measures that seek out qualified candidates from hard-to-reach segments of society through wider publication of job vacancies. They should also invest in the training of women and underrepresentation groups to meet the requirements for jobs in sectors where they are underrepresented. These actions are necessary to correct historical disadvantages suffered by women and marginalized groups.

These recommendations support the section/paragraph(s) in the RSSR that encourages Member States to ensure that *all citizens enjoy equal opportunities, without discrimination, for the initial education and training needed to qualify for research and development careers*, as well equal access to available employment in scientific research for the qualified citizens (UNESCO, 2018, p.10).

Open and equitable access to research and knowledge *(including "sharing of the whole scientific process")*

Member States should invest in open access initiatives for the purpose of keeping researchers up to date with advancements in scientific knowledge and know-how in their chosen fields. Open access

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to knowledge and scientific resources plays a fundamental role in empowering researchers with the tools needed for successful conduct of research which serves as a mean to sustainable development. This recommendation can be achieved through the provision of broadband internet facilities to improve access to knowledge, free access to international databases and journals, libraries, and other sources of information, as well as enhancing researcher's capacities publish in open access journals and platforms. This will help bridge the knowledge gap between developed and developing countries and improve the prospect of sustainable development across different regions of the world.

This recommendation supports the section/paragraph(s) in the RSSR that encourages Member States to *ensure equitable and open access to scientific literature, data and contents including by removing barriers to publishing, sharing, and archiving of scientific outputs* (UNESCO, 2018, p.11).

Promoting ethical and responsible conduct of research and development *(including role/responsibility of science in society)*

International organisations, Member States and professional bodies should develop legal frameworks, regulations, and codes of conducts to guide research in potentially dangerous areas that may lead to the production of potentially dangerous and hazardous substances. This will ensure that such research and its outcomes are not misused or misapplied, leading to the development of weapons of mass destruction. They are to invest in research that seeks to understand the root causes of conflict and find ways of resolving them to build peace and sustainable development.

This recommendation supports the section/paragraph(s) in the RSSR that encourages Member States to *establish suitable means to address the ethics of science and of the use of scientific knowledge and its applications* (UNESCO, 2018, p.8).

National and international cooperation and partnerships with state and non-state actors

Member States, international organisations and research funding organisations should provide avenues for healthy scientific collaborations and partnerships between developing and developed countries. They should ensure that such collaborations are built on mutual trust and the active participation of all the partners in such a way that the knowledge generated is co-created and all the contributions are adequately acknowledged and rewarded. Finally, they should ensure that the knowledge generated is transferred back to the local communities and used for the betterment of societies across the world. This will facilitate the empowerment and development of local scientific capacities, empower local researchers and communities, reduce the rate of brain-drain from developing countries and reduce inequality within and among countries.

This recommendation supports the section/paragraph(s) in the RSSR that encourages Member States to *establish partnerships freely associating scientific communities of developed and developing countries to meet the needs of all countries and facilitate their progress while respecting national regulation* and other recognised agreements (UNESCO, 2018, p.14).

Limitation

The mapping exercise has some of element of subjectivity as it is based on the interpretation of the RSSR and SDG documents by the reviewers (coders). However, the reviewers' expertise in gender

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equality, diversity and inclusion and clarity of the textual data in the documents reviewed led to a high degree of consistency between the reviewers.

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Chapter 3: Public and Stakeholder Engagement

Fabio de Castro and Bafedile Kgwadi

1. Introduction

This report is part of the Task 6.1 which addresses the connection between two documents: Recommendation on Science and Scientific Researchers (RSSR) prepared by UNESCO and the Sustainable Development Goals (SDGs) of the United Nation's Agenda 2030. The main goal is to identify how RRI principles elaborated in the RSSR can be applied in the implementation of the SDGs. The aim of this exercise is to create synergies between both documents. SDGs have become a strategic document to develop sustainable pathways. However, it lacks more clear guidelines on how each goal must be tacked. In order to promote research and innovation to achieve SDGs under high levels of global inequality, power structures and cultural diversity, clearer guidelines for science and technology (S&T) research is needed. The RSSR provides an important source of principles that are useful to support the implementation of SDGs. In the Preamble, the document recognises that "Member States should develop or dvise machinery for the formulation and execution of adequate policies, that is to say, policies designed to avoid the possible dangers and fully realize and exploit the positive prospects inherent in such discoveries, technological developments and applications."

This report is focused on the implementation of public and stakeholder engagement in research and innovation to achieve the SDGs. Cooperation is stated in the preamble of both RSSR and SDGs as vital to tackle societal challenges. However, how engagement should take place is a contested issue. Citizen engagement is often conceptualized by industries and governmental organizations through participation as beneficiaries whereas minority groups claim for full engagement from design to implementation and benefit sharing. Transnational cooperation (and North-South cooperation in particular) are marked by asymmetric relations and dominating perspectives. Therefore, a more transcultural perspective of engagement is needed for the SDGs.

The methodology used was a stepwise mapping process. First, engagement-related issues identified in the RSSR were coded and analysed. This process allowed for a broader categorisation of engagement process that are relevant to the implementation of SDGs. Second, these categories were mapped onto the SDGs in order to identify where engagement is relevant to achieve the SDGs. Finally, a set of recommendations to improve the consideration of RRI principles in the implementation of SDGs is provided.

Recommendations are based on general and specific goals. The former addresses practice and institutionalization of engagement whereas the latter addresses engagement in more specific arenas such as conservation, energy and food research.

2. Results

This section presents the two analytical steps. In the first part, I discuss the codes that emerged from the RSSR and group them into larger categories. For each category, a short description of the theme is elaborated according to the text from the RSSR. In the second part, I articulate the RSSR coding with the SDG document, identifying key intersections and possible contribution to improve the implementation of SDGs at broad and more specific levels.

2.1. Results theme-specific analysis of RSSR:

Public and stakeholder engagement is addressed in detail in a range of aspects of research and innovation by the RSSR. Engagement is a transversal theme as it intersects with gender and diversity

inclusion, ethical considerations and education. In order to avoid overlap, the coding was focused on more general aspects of engagement. The coding process was based on a systematic process of identification of text where themes related to engagement were identified. Table 1 (see Annex 1) shows a total of 16 text excerpts from the RSSR, organized in sub-themes and aggregated codes. This section provides the analysis of these information, and the results emerging thereof. The findings are structured into 5 aggregated themes in which public and stakeholder engagement is central. Each theme represents a different facet of engagement in research and innovation.

Theme 1: Engagement in research agenda addresses the problematization of prioritization of research themes. This is the 'step-zero' of research policy-making which is often marked by exclusion and asymmetries. It influences research practice which is the second facet of engagement.

Theme 2: Engagement in research practice is how research is performed on the ground and knowledge is built. Engagement in collaborative research ranges between co-creation and knowledge exploitation. This links to the third facet.

Theme 3: Engagement in knowledge sharing, which relates to how new knowledge is made accessible and used across stakeholders. Access to new knowledge intersects with Open Science, a point of contention among private stakeholders and citizens with limited technology.

Theme 4: Engagement in research facilitation refers to the range of mechanisms that enable collaborative research such as procedures, formats and practices. It addresses the hurdles of conventional research models and the ways full engagement can be promoted.
Theme 5: Engagement in research appraisal includes the institutional formula for assessment of academic performance. It addresses the uncalculated costs of collaborative research and the need to transform conventional metrics into more inclusive and qualitative in order to create incentives for engagement in multi-stakeholder collaborations.

2.1.1. Engagement in Research Agenda

Research agenda is the "step-zero" in research policy-making. It has major influence on research through the prioritization of themes, training and funding programs. Therefore, public and stakeholder engagement in this phase is vital to ensure a more inclusive perspective in science and technology development. The RSSR addresses structural factors hindering engagement in research agenda setting and funding and highlights the importance of "scientific researchers to participate in developing national science, technology and innovation policy" (8). Engagement in debates around research agenda requires not only creation of dialogue spaces but also of a scientific culture, public trust, and transparency. This aspect is addressed by the RSSR as it calls for the "strengthening of scientific culture, public trust and support for sciences throughout society, in particular through a vigorous and informed democratic debate on the production and use of scientific knowledge, and a dialogue between the scientific community and society" (5c). Public and stakeholder engagement in the research agenda is particularly important not only to reconcile scientific agendas with societal demands but also to amplify the synergies among multiple perspectives, ethics and knowledge sources, and avoid single-sighted agendas with potential societal harm.

2.1.2. Engagement in Research Practice

Research practice is the most visible aspect of engagement. It is research in action where new knowledge is produced, articulated and materialized in innovation. Engagement in research practice requires clear collaboration terms regarding roles, purposes, sphere of participation, data access, among others. The RSSR addresses how inequality in research training and production limits engagement and highlights the relevance of engagement of multiple actors in knowledge building. It highlights the relevance of interdisciplinary and transdisciplinary encounters by stating that "science brings together in a coordinated form subsystems of knowledge by means of systematic reflection and conceptualization" (1a/b). Recognition of multiple knowledge systems, however, does not suffice to promote knowledge co-production. Proper training is needed to support the bridging of multiple

mental models upon which contrasting theoretical, methodological and analytical perspectives are grounded. In order to ensure inclusion and eliminate bias, the RSSR gives special attention to increase diversity in research. It emphasizes the "all citizens enjoy equal opportunities for the initial education and training needed to qualify for research and development careers, as well as ensuring that all citizens who succeed in so qualifying enjoy equal access to available employment in scientific research" (13a). In particular, it "actively encourage women and persons of other under-represented groups to consider careers in sciences" (13c). Finally, the document recognises informal settings as a relevant training arena "strengthen all sciences, technology, engineering and mathematics education, in schools and other formal and informal settings (14a)". Although not explicitly mentioned, this is particularly relevant to traditional populations and recognition of traditional knowledge systems which are reproduced over generations through praxis. In sum, training in science education is emphasized as an important strategy to include under-represented groups and different forms of education settings and methods.

2.1.3. Engagement in Knowledge Sharing

Engagement in research must ensure proper data and benefit sharing among all partners, an issue that also intersects with ethical considerations. Research collaboration under highly asymmetric grounds often leads to unequal sharing. In particular, partnership between developed and developing countries may create exploitative relations of knowledge extraction and partial return of the innovation emerging from the collaboration. Reference to freedom to develop transnational partnerships and ensuring benefit sharing is emphasized in the RSSR. However, due account of power structures and different values in collaborations between asymmetric actors (e.g., developed and developing countries; industry and civil society) needs more attention. RSSR addresses two relevant aspects related to this issue. First, promoting fair collaborative research agreements between developed and developing countries under equal grounds as stated "establishing partnerships freely associating scientific communities of developed and developing countries to meet the needs of all countries and facilitate their progress while respecting national regulation, including cultural and scientific cooperation and development of bilateral and multilateral agreements enabling developing countries to build up their capacity to participate in generating and sharing scientific knowledge, the related know-how and their benefits (18a)". A second aspect is the procedures for terms of collaboration which should include full participation of the communities concerned - "the when negotiating a research agreement and terms for collaboration, agreement on the benefits of the research and access to the results should be established with full participation of the communities concerned" (20c).

2.1.4. Engagement in Research Facilitation

Engagement in research requires is often limited by conventional institutional arrangements and practices. In order to promote full engagement, new procedures, formats and practices. need to be implemented. The RSSR elaborates on a range of mechanisms to facilitate participation of multiple stakeholders. On key aspect is funding by different sources as elaborated in the document - "promoting research and development in all areas of society, funded by public, private and non-profit sources". At the same time, donors should provide academic freedom and creativity needed - "scientific researchers respect public accountability while at the same time enjoying de degree of autonomy appropriate to their task and to the advancement of science and technology" (10). Private funders may, however, create restrictions upon scientific researchers' right to publish or communicate results; in those cases, "Member States should ensure: (a) that such restrictions are: strictly minimized, consistent with public interest and the right of their employers and fellow workers, consistent with appropriately crediting and acknowledged contributions of scientific researchers to the results obtained, and properly communicated as clearly as possible in writing in the terms and conditions of their employment" (38). Another important aspect for engagement is access to technology for communication and data sharing. RSSR highlights the role of open science in this issue by stating "policies aiming to facilitate that the scientific researchers freely develop and contribute to

sharing data and educational resources, for example by means of virtual universities" (18c) and that "Member States should establish and facilitate mechanisms for collaborative open science and facilitate sharing of scientific knowledge while ensuring other rights are respected" (21). Finally, mobility of scientific researchers is vital to enable collaboration. The document states that "Member States should enable and facilitate mobility of scientific researchers between public sector, private sector and higher education employment, as well as outside of research and development" (29) and that "Member States should actively promote the interplay of ideas and information among scientific researchers throughout the world, which is vital to the healthy development of the sciences; and to this end, should take all measures necessary to ensure that scientific researchers are enabled, throughout their careers, to participate in international scientific and technological community. These facilitation mechanisms, however, must take due account of power structures, cultural differences, language barriers, communication formats and technological inequality across stakeholders and countries.

2.1.5. Engagement in Research Appraisal

Engagement in research requires incentives from all stakeholders. Motivations vary across stakeholders, and performance appraisal is key for scientific researchers. Although collaboration may deliver significant added value to research, it also has major costs that are often not considered in performance appraisal. Intangible values such as community outreach, science communication, social development are overshadowed by high impact factor academic publications. The RSSR document calls for the recognition of time and efforts spent in public and stakeholder engagement in research performance evaluations as described in a more inclusive list as "take due account of all aspects of the work including, inter alia, contributions to publications, patents, management, teaching, outreach, supervision, collaboration, ethics compliance, and science communications" (34a). It also acknowledges the need of new metrics by stating "combine appropriate metrics with independent expert assessment (peer review) of the individual's outputs, as to all aspects of the work including those aspects mentioned above in (a)" (34c), which could include qualitative indicators.

2.2. Linking the RSSR to the 17 SDGs: connections, disconnections and opportunities

This section presents the connection between the coding of the RSSR to the SDGs. The aggregated categories elaborated in the previous section are linked to general and more specific SDGs. Considering the broad range of themes addressed by the SDGs, more specific themes were limited to conservation issues, namely SDG 6, SDG 7, SDG 12, SDG 15 and SDG 17. In the following paragraph, I present a more general articulation of how public and stakeholder engagement is addressed by the SDGs, before delving into the intersect between RSSR and the SDGs and their potential synergies.

2.2.1. General articulation of public and stakeholder engagement by the SDG Agenda

Public and Stakeholder Engagement in research and innovation is a transversal component of the SDGs agenda. Based on intensive public consultation and engagement with civil society and other stakeholders (6), it is presented as an 'agenda of the people, by the people and for the people' (52). This people-centric perspective is grounded on principle of global partnership which recognizes multiple contexts, visions and practices (59). It calls for full participation in society for the implementation of the goals (25,27), and for intercultural understanding grounded on global citizenship and shared responsibility (36). SDGs aims to move beyond the knowledge and technology provider-beneficiary positions of the Global North/Global South during the MDG agenda, and shape a truly global participatory agenda. In addition, it aims at avoiding perverse outcomes from single-sighted, technical-based solutions for short-term goals observed in the past. Examples of these cases are innovations on food production through genetically modified organisms which has driven land grabbing, food corporation control, air contamination and health problems, to name only a few.

Similarly, energy transition through development of agroenergy (e.g., biodiesel and ethanol) has driven deforestation, land concentration, rural conflicts, and food insecurity. Therefore, public and stakeholder engagement is vital to ensure full participation of all relevant actors concerned in complex issues crossing multiple interests.

The SDGs are divided into three main pillars – social development, sustainability and institutional strengthening. Public and stakeholder engagement is conceptualized in many parts of the text while its operationalization is provided in the third pillar. International cooperation is emphasized in several SDGs (1a, 2a, 4c, 6a, 14.3, 15.6), knowledge sharing and access is highlighted in SDGs 4.7 and 12.8, training in the Global South in SDGs 4b and 11.3, engagement local communities and traditional knowledge in SDGs 6b, 7a, 9b and 15c, engagement of developing countries in decision-making in SDGs 10.6 and 16.8, and engagement of companies in sustainable practices in SDG12.6. Operationalization in provided in SDG 17 in different dimensions:

- Financial: "mobilize additional financial resources for developing countries from multiple sources") – (17.3)
- Technology: "Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism" (17.16)
- Institutional: "Multi-stakeholder partnerships through the Global Partnership for Sustainable Development, complemented by multi-stakeholder partnership that mobilize and share knowledge, expertise, technology and financial resources" (17.16); and Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships"(17.17)

The implementation plan is further developed through the "Technology Facilitation Mechanisms which is based on a multi-stakeholder collaboration… and inter-agency task team on science, technology and innovation for SDG" (70).

2.2.2. Intersect between RSSR and the SDGs and their potential synergies

Despite these financial, technological and institutional mechanisms provided by the institutional strengthening pillar of the SDGs, the implementation of public and stakeholder engagement in the social development and sustainability pillars is rather vague. For example, 17.16 calls for the enhancement of Global Partnership for Sustainable Development which supports data sharing across different stakeholders; however, this platform is still limited to large players (e.g., Business and NGOs). SDG 17.6 and 17.7 tends to emphasize one-way technology transfer (from developed to developing countries). This perspective is based on a research agenda based on high technologies driven by corporations and overlooks the possibility of small-scale technological development emerging in developing countries to be transferred/applied to developed countries. 15.6 calls for promotion of fair and equitable benefit sharing from utilization of genetic resources. However, increasing interest in bioeconomy calls for close attention to under which condition partnerships and agreements are made in order to avoid perverse outcomes observed in the past.

Considering the highly unequal and diverse global society, effective engagement is challenged by persistent power structures and contrasting perspectives. In order to avoid dominance of powerful actors (e.g., industrialized countries, corporations, international funders), public and stakeholder engagement in science-based solutions to achieve SDGs must be ensured. Many participatory initiatives developed over the last decades such as consultations, round tables, public hearings, multi-stakeholder dialogues have rendered limited engagement at best, and legitimized business as usual practices at worst. Therefore, a solid strategy for effective engagement in research and innovations to address social development and sustainability is needed.

The SDG agenda, however, lacks clear directions on how engagement can be shaped. Based on the analysis of the RSSR document, three main intersecting topics have emerged.

2.2.2.1. Engagement in Research Practice

The RSSR addresses how inequality in research training and production limits engagement and highlights the relevance of inclusion of multiple actors in knowledge building. Multiple knowledge systems is recognized in definition of science (1a/b). Training in science education is emphasized as an important strategy to include under-represented groups and different forms of education settings and methods. The latter is particularly relevant for traditional populations and recognition of traditional knowledge systems.

As mentioned in the previous section, traditional knowledge systems are relevant to a range of SDGs. In particular, SDG 6a and 7a calls for international cooperation and capacity building in development of clean energy research and technology and water-and sanitation-related activities and programs. Engagement of actors relevant to the whole supply chain of green energy technologies is crucial for anticipation and reflexivity. Clean energy may have impacts on supplier countries as the bioenergy directive has shown. Current innovation development of electric vehicles, for instance, requires increased supply of lithium. Lithium reserves are concentrated in a few countries and local territories (e.g., Chile and Bolivia) which may generates impacts in local livelihoods. Likewise, strengthened participation of local communities in improving water and sanitation management is needed.

Research and innovation programs must be structured as transdisciplinary teams and cultural differences and power structures must be taken into account in the way collaboration is shaped. Transdisciplinary research is supported by the RSSR regarding relevance of inclusion of traditional knowledge systems.

2.2.2.2. Engagement in Research Facilitation

The RSSR document elaborates on a range of mechanisms to facilitate engagement of multiple stakeholders, from funding, to technology for communication and data sharing, and opportunity for mobility. These mechanisms must take due account of power structures, cultural differences, language barriers, communication formats and technological inequality across stakeholders and countries. SDG 17 has a strong component on research facilitation, providing a model for funding, training, collaboration, and data sharing. However, although international cooperation is emphasized in several SDGs (1a, 2a, 4c, 6a, 14.3, 15.6), research facilitation emphasizes engagement of powerful players (industries and transnational NGOs). SDG 15.6 calls for promotion of fair and equitable benefit sharing from utilization of genetic resources. However, increasing interest in bioeconomy calls for close attention to the conditions partnerships and agreements are facilitated. Use of genetic resources is a particular point of concern. SDG 15.6 highlights the need to promote fair and equitable sharing of benefits and appropriate access. However, previous experiences show that institutional arrangement do not suffice to ensure autonomous decision by concerned communities and prevent appropriation of their knowledge by external actors. Therefore, engagement in research facilitation must include mechanisms that also prevent perverse engagements and mechanisms that foster local empowerment in partnerships negotiations.

2.2.2.3. Engagement in Research Sharing: The RSSR addresses the relevance of collaborative research and data sharing. It emphasizes the freedom to develop transnational partnerships and ensuring benefit sharing; however, due account of power structures and different values in collaborations between asymmetric actors (e.g., developed and developing countries; industry and civil society) must be taken. Although local knowledge is emphasized in several SDGs (6b, 7a, 9b and 15c), it emphasizes North-South knowledge transfer and does not acknowledge the relevance of South-North knowledge transfer. SDGs 12.8, for example, calls for relevant information and awareness for sustainable development and lifestyles in harmony with nature available to everyone. This is in line with practices developed in the Global South which could be transferred to the Global North. The South-North

knowledge transfer, however, requires concerted efforts to decolonize development pathways and include new communication channels supported by technology access (e.g., social media), transdisciplinary research and intercultural spaces, and development of new narratives and citizens mobilizations.

3. Recommendations

Public and Stakeholder Engagement in research and innovation is value-charged and, often times, carried out under asymmetric relations. As a result, high level of engagement does not necessarily mean 'effective participation'. By the same token, disengagement may represent conscious decision from marginalized groups to avoid misuse of their participation. Empirical evidence from the Global South indicates that the degree and quality of engagement depends on how participation is conceptualized and implemented. Therefore, the achievement of SDGs depends on a co-production from multiple worldviews, values, practices, and knowledges. Based on this premises, our recommendations are related to three main aspects of research and innovation. 1) engagement in knowledge building; 2) engagement in data sharing; and 3) Provision of tools for engagement

Theme 1: Engagement in Research Practice

1) Several SDGs call for international cooperation and capacity building support to developing countries (1a, 2a, 4c, 6a, 14.3, 15.6), and strengthen the participation of local communities in improving local management (6b, 7a, 9b and 15c). This strategy is supported by the RSSR regarding relevance of inclusion of traditional knowledge systems (transdisciplinary research).

Recommendation

Research and innovation programs structured as transdisciplinary teams

Cultural differences and power structures must be taken into account in the way collaboration is shaped.

Implementation

- Curriculum of technical programs (e.g., engineering) favoring interdisciplinary courses
- Funding programs for transdisciplinary projects

2) Several SDGs call for technology development and transfer. Focus on high technology and one-way North-South transfer reproduces unequal grounds for research engagement between actors from developed and developing countries, and enhance spatial inequalities. Clear energy is a case in point. Current development of electric vehicles requires increase supply of lithium which is concentrated in a few countries and local territories (e.g., Chile and Bolivia). Increased demand of lithium may generates impacts in local livelihoods. A decolonial perspective to engagement in research practice is needed in order to allow for equal grounds in engagement from design to knowledge sharing and take the whole supply chain into account.

Recommendation

Engagement of actors relevant to the whole supply chain of green energy technologies is crucial for anticipation and reflexivity.

Implementation

- Strict regulations of supply chain for clean energy technologies
- Implementation of autonomous local consultation for concession of extractive industry related to clean energy technology

- Definition of criteria for sustainable production based on environmental and social indicators with local representation

Theme 2: Engagement in Knowledge Sharing

3) 17.16 calls for the enhancement of Global Partnership for Sustainable Development. This initiative supports data sharing across different stakeholders. However, it is still limited to large players (e.g., Business and NGOs).

Recommendation

GPSD must be adjusted in order to improve access to a broader range of stakeholders

Implementation

- Support to national programs to increase public stakeholder engagement in the GPSD platform
- Creation of language-specific versions for engagement of local stakeholders
-

4) 15.6 calls for promotion of fair and equitable benefit sharing from utilization of genetic resources.

Recommendation

Increasing interest in bioeconomy calls for close attention to under which condition partnerships and agreements are made.

Implementation

- Creation of autonomous multi-stakeholder assessment of bioeconomy projects with strong local representation
- Definition of partnership and criteria for benefit sharing with local representation

Theme 3: Engagement in Research Facilitation

5) SDG 12.8 calls for relevant information and awareness for sustainable development and lifestyles in harmony with nature available to everyone.

Recommendation

This goal requires concerted efforts including communication channels supported by technology access (e.g., social media), transdisciplinary research and intercultural spaces, and development of new narratives and citizens mobilizations.

Implementation

- Funding programs on citizen-based online communication channels
- University extension programs
- School programs on sustainable consumption

Chapter 4: Open Access and Open Science

Andrew Adams

1. Introduction

As one of the key elements of RRI, the RRING project has explored various aspects of Open Access (OA) and Open Data (OD) and associated issues throughout its activities. As the landscape of RRI evolves, OA and OD are now being seen as part of a broader set of moves towards the concept Open Science **(**Vicente-Sáez & Martínez-Fuentes, 2018), which includes connections to other areas of RRI (most notably public engagement and research integrity) but also to new areas such as citizen science. See other RRING reports such as the WP4 deliverables for more details of these links. The broad nature of the RSSR and the SDGs mean that they include significant aspects linked to these other concepts as well, some of which are addressed by other parts of the RRING team in this task. Hence there are almost certainly some overlaps with other issues.

On of the key issues in the SDGs is that of improving the situation of countries with under-developed economies, and there are specific acknowledgements in the SDGs that in many areas, research and innovation activities are likely to be key in achieving the goals. In addition to the issues of Open Access, Open Data and Open Science (OADS), this report has also identified areas of overlap between RRI, the RSSR and the SDGs which relate to the specific task of development of under-developed economies.

2. Results

The following other issues were identified within the texts of the RSSR and/or the SDGs:

Open Science	Open Access	Open Data	Development
Academic Freedom	Ability to Publish	Access by Policy-makers/influencers	Brain Drain
Indigenous Knowledge	Access by Policy-makers/influencers	Copyright, Patents, Design Rights	Indigenous Knowledge
Public Understanding	Brain Drain	Education	Capacity Development
Scientific Integrity	Censorship	Hiring/Promotion Criteria	
	Copyright, Patents, Design Rights	Privacy/Data Protection	
	Education	Upstream Data	
	Hiring/Promotion Criteria		
	International Communication		
	Machine-reading		
	OERs		
	Public Understanding		
	Quality and Peer Review		
	Subscription Costs		
	Role of Member States		

2.1. Results theme-specific analysis of RSSR:

The RSSR is an expression of an ideal towards which humanity should strive in ensuring that science progresses and in progressing supports rather than oppresses humanity. As such it is hardly surprising that it contains many issues and themes resonating with OADS and science for economic development of countries with under-developed economies. In addition to direct promotion of OA and OD (for example the text of section III. 13 (e): "Member States should take measures to: [...] (e) ensure equitable and open access to scientific literature, data and contents including by removing barriers to publishing, sharing and archiving of scientific outputs."*)*, t

In addition to elements which aim to improve society through the medium of science, the RSSR also includes aspects aiming to improve the conduct of science, both in its role in improving society (e.g. encouraging public engagement) but also by seeking to ensure that scientists are appropriately supported in performing their work. All of these elements interact with the issues of OADS in both directions: sometimes the contents of the RSSR support the development of OADS, sometimes the elements of OADS are stated or implied to be necessary to achieve other goals of the RSSR.

Many of the issue identified have overlaps, often reinforcing each other, but sometimes in tension (e.g. open data and patents). After presenting the elements of the RSSR that quite directly promote OADS, these various overlapping elements are presented below.

Direct Support for OADS

OA, OD and OS are mentioned explicitly in the declaration a number of times. In section III. 13. (e) Member states are expected to take measure to "ensure equitable and open access to scientific literature, data and contents including by removing barriers to publishing, sharing and archiving of scientific outputs." while section IV. 16. (a). (v) stresses the right of researchers "to promote access to research results and engage in the sharing of scientific data between researchers,[...]".

Just below this, the RSSR also implies that open access should be encouraged by Member States in order to fulfil the potential of science worldwide:

IV. 18. (b) Member States should recognize the international dimensions of research and development and, in this regard, should do everything possible to help scientific researchers, including:
[...]

(b) ensuring equal access to science and the knowledge derived from it as not only a social and ethical requirement for human development, but also as essential for realizing the full potential of scientific communities worldwide;

In IV. 21. direct mention is made of Open Science as an intended goal of Member States supported by the RSSR:

IV. 21. So as to ensure the human right to share in scientific advancement and its benefits, Member States should establish and facilitate mechanisms for collaborative open science and facilitate sharing of scientific knowledge while ensuring other rights are respected.

In sections V.27 and V.28 OA and OD are noted as elements of what Members states should be providing to people engaged in research:

V.27 Member States should develop policies with respect to employment that adequately cover the needs of scientific researchers, in particular by:
[...]
(f) promoting and supporting open scholarship by scientific researchers, as well as promoting open access to literature and research data, as essential parts of research.

V.28 Member States should encourage the provision of facilities so that scientific researchers enjoy lifelong opportunities for keeping themselves up to date in their own and in other scientific fields, by attendance at conferences, by free access to international databases and journals, libraries and other sources of information, and by participation in training

In sections V.36 member States are encouraged to promote OA:

V.36 In order to promote science as a public good, Member States should encourage and facilitate access to knowledge, including open access.

Access by Policy-makers/influencers

Section IV. 16. (a). (v) on the rights of scientific researchers:

(v) to promote access to research results and engage in the sharing of scientific data between researchers, and to policy-makers, and to the public wherever possible

stresses that alongside access by other researchers, OA is one of the mechanisms by which the results of science aid society, in this case noting that OA is useful in providing access to members of the public and policy-makers. The necessity of access by policy-makers (which is improved by OA) is also implied by the declaration in sections II. 4 and II.7 which stress that policy should be made based upon scientific and technical knowledge:

II. 4. Member States should establish and substantially strengthen human and institutional capacities, including by: (g) using scientific and technological knowledge in decision-making and policies.

II. 7. Member States should use scientific and technological knowledge in decision-making and policies for international relations, for which they should strengthen capacities for science diplomacy.

Ability to Publish; Censorship

While promoting OA and OD in order that other researchers (and policy-makers and non-researchers) can easily access the work of researchers, the RSSR stresses that Member States should both promote publication of results and not censor research results. Thus the right of researchers, and the obligation of researchers, to openly communicate their results is stressed a number of times in the declaration. The right of researchers to disseminate their work is recognised in sections V. 38 and V. 39, including the right to interact with their peers.

V. 38. In those cases where restrictions are placed upon scientific researchers' right to publish or communicate results, Member States should ensure: (a) that such restrictions are: strictly minimized, consistent with public interest and the right of their employers and fellow workers, consistent with appropriately crediting and acknowledged contributions of scientific researchers to the results obtained, and properly communicated as clearly as possible in writing in the terms and conditions of their employment; (b) that the procedures by which scientific researchers can ascertain whether the restrictions mentioned in this paragraph apply in a particular case and by which mechanism they can appeal are made clear.

V. 39. Member States should ensure that scientific researchers may: (a) receive without hindrance the questions, criticisms and suggestions addressed to them by their colleagues throughout the world, as well as the intellectual stimulus afforded by such communications and the exchanges to which they give rise; (b) enjoy in tranquillity international acclaim warranted by their scientific merit.

The importance of researchers not only interacting with each other, but also with the rest of society nationally and internationally is promoted in section IV. 16. (a) (iv) as a right of researchers:

to contribute constructively to the fabric of science, culture and education, and the promotion of science and innovation in their own country, as well as to the achievement of national goals, the

enhancement of their fellow citizens' well- being, the protection of the environment, and the furtherance of the international ideals and objectives;

Ability to Publish; Copyrights, Patents, Design Rights

While generally promoting the publication of research results with maximum achievable openness (OA, OD and OS), the RSSR acknowledges that some of the outputs of research lead to financially exploitable results which may require the protection of copyright, patents or design rights in order to allow their exploitation (V. 18), and stresses the researchers should receive suitable individual benefits from such outcomes (V. 16. (b) (iii)). In other RRING research, these issues were raised by participants as potentially incompatible with some forms of open mandates (OD particularly). The RSSR recognises that sometimes a balance needs to be struck between exploitation and openness in Section IV. 18. (d):

Member states should help researchers to:
(d) in the context of their intellectual property regime, ensuring that contributions to scientific knowledge are appropriately credited, and balancing between protection of intellectual property rights and the open access and sharing of knowledge, as well as ensuring the protection of sources and products of traditional knowledge;

The last phrase in that section links the issues of open dissemination not only to the individual rights of the researchers, but to the rights of indigenous groups whose resources may have been a crucial component in the research. This reflects a statement in the preamble, (paragraph 13) stressing the benefits of science to indigenous groups, but only where they are given suitable recognition of their contribution.

Copyrights, Patents, Design Rights; Indigenous Knowledge

In addition to the rights of indigenous groups to benefit from the results of science based or partly based on their resources, the RSSR recognises that the current global economic system is unbalanced and that science as a system is tilted in favour of countries with developed economies in a way that perpetuates the problems of countries with under-developed economies. As discussed in other RRING reports on OADS, the current pay-to-read system of academic publishing and lack of open data provision is a key part of this problem. Moves to a pay-to-publish system may well duplicate the effects of this system or even exacerbate it. Researchers in countries with under-developed economies often cannot access the current upto-date body of knowledge, making it impossible for them to perform high quality research on their own. Partnering with researchers in countries with more developed economies can sometimes help with this, but the long term outcomes of this are more often that the best researchers from countries with under-developed economies then gain opportunities to move to countries with more developed economies, creating a "brain drain". This is recognised in the preamble at paragraph 18:

Conscious that the phenomenon frequently known as the "brain drain" of scientific researchers has in the past caused widespread anxiety, and that to certain Member States it continues to be a matter of considerable preoccupation; having present in mind, in this respect, the paramount needs of the developing countries; and desiring accordingly to give scientific researchers stronger reasons for serving in countries and areas which stand most in need of their services,

Hiring/Promotion Criteria; Indigenous Knowledge

Section II. 11. stresses the need for member states to provide suitable situations to facilitate the development of scientists in their preferred location. One aspect of that is providing read and write access to the scientific literature without significant barriers. These existing (primarily economic) barriers to success as scientists (and the potential for new pay-to-write barriers emerging from one route towards a free-to-read system) are linked not only to inequalities between countries, but inequalities between groups. Privileged groups in societies (based on gender, sexuality, physical

ability, ethnicity) retain and increase their non- meritocratic advantages partly due to the lack of OA/OD but also due to the related issue of how hiring and promotion criteria within science are based on simplistic and outmoded recognition markers (primarily locus of publication and citation counts of that locus and of the articles themselves). As discussed in other RRING reports on OADS, the existing system of scientific reputation needs overhauling to better recognise and reward everyone engaged in science, at all stages of their careers and within multiple occupational frames. Sections V.34 and V.35 of the RSSR recognise this and specifically link some of the required reforms to supporting OADS practices:

V. 34. Member States should, as regards scientific researchers in their employ, design and establish appropriate (using international comparisons so as to adopt good practices) appraisal systems for independent, transparent, gender-sensitive and tier-based performance evaluation that:

[...]
(e) encourage, by means of incentives, sharing of the whole scientific process (data, methods, software, results, etc.) and mentoring early career people in the sciences.

V. 35. Member States should encourage and facilitate publication of the results obtained by scientific researchers, and extend this to the data, methods, software, that they used, with a view to assisting them to share scientific information, and to acquire the reputation that they merit, as well as with a view to promoting the sciences, education and culture generally.

The RSSR is permeated by recognition of the benefits of adoption of greater openness is scientific endeavour, which will improve its outcomes overall as well as improve the equal sharing of its benefits.

2.2. Linking the RSSR to the 17 SDGs: connections, disconnections and opportunities

The RSSR was an updated and strengthened version of a 1974 declaration and was agreed in 2017. The discussions around the adoption of the RSSR were heavily informed by the SDGs. The nature of the two documents differs in a number of different ways but in particular the SDGs are a time-specific set of goals. They are intended to be ambitious goals for human development by 2030. Just as the Millennium Development Goals were absorbed and superseded by the SDGs, it should be expected that by 2030 at the latest, further ambitious goals will emerge to absorb and supersede the SDGs. The RSSR on the other hand is intended as a longer-term human rights declaration. As such, the RSSR embodies many of the same ambitions of the SDGs but does not specifically refer to them. One of the goals of this current task in the RRING project is to make these connections clear in the context of how RRI, the RSSR and the SDGs are mutually reinforcing or, sometimes, in tension.

In the area of OADS, there are only a few tensions, and those tensions are mostly inherent already in the practices of science. As noted above, the tension between OADS and financial exploitation of results is an obvious one.
The achievement of the SDGs can be aided by OADS in ways that are compatible with the RSSR's support of the OADS aspects of RRI in various ways. The RRI-related issues identified during the consideration of the RSSR which were identified as being highly relevant to specific targets of SDGs were:

Development of Under-developed Economies: Indigenous Knowledge Open Access: Direct
Open Access: Access by Policy-makers/influencers
Open Access: Copyright, Patents, Design Rights

Open Access: Machine-reading Open Access: OERs
Open Access: Public Understanding Open Access: Subscription Costs Open Data: Direct

Open Data: Upstream Data
Open Science: Academic Freedom
Proponents of OADS claim (Vicente-Sáez, & Martínez-Fuentes, 2018) that these practices and systems improve the outcomes of science both within the frame of science itself (scientific integrity), but also in a number of ways that benefit society more broadly: improving the targeting of resources devoted to science such that the outcomes are more useful to society; ensuring that the outcomes of science are in a form reasonably well-suited to be exploited for the betterment of society. So long as these claims of OADS proponents are true, then any and all of the SDG Targets which are either only achievable via research and innovation, or which can be achieved more quickly/efficiently/with fewer side effects, via research, should be improved by the adoption of OADS practices. In this document, these SDGs and OADS practices which have specific connections to each other and to the RSSR, are presented.

Development of Under-developed Economies: Indigenous Knowledge; (Prevention of) Brain Drain; Capacity Development

SDGs 2 and 11, specifically targets 2.5, 2.a and 11.4 relate to the issue of development of under-developed economies and concern ensuring that the benefits of science based on local resources (bio-resources, raw materials, indigenous knowledge and local research talent) generate local development rather than overseas profit (usually accruing to those in already developed economies).

SDG 2; Target 2.5:
By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed.

SDG 2; Target 2.a:
Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries.

SDG 11; Target 11.4:
Strengthen efforts to protect and safeguard the world's cultural and natural heritage.

These targets can be linked to the RSSR text in IV. 18. (d)
Member states should help researchers to:
[...]
(d) in the context of their intellectual property regime, ensuring that contributions to scientific knowledge are appropriately credited, and balancing between protection of intellectual property rights and the open access and sharing of knowledge, as well as ensuring the protection of sources and products of traditional knowledge;

Open Access: Direct

As noted above, Open Access, and the related issues of Open Data and Open Science, are all directly promoted in the RSSR as being part of "good science" and as part of ensuring that research works to benefit society as a whole and to the maximum extent, instead of being the preserve of an elite and a method of retaining and expanding the reach of existing power blocs. As Oladokun & Oyelabi (2021) note, access to current research information is a highly valuable tool in various aspects of economic development, not least in promoting higher education. As such, many aspects of the SDGs would be more easily achieved if researchers, students, entrepreneurs, policy-makers etc. had free-

to-read access to the world's scientific output. Of course, the contents of the academic literature are not always fully accessible even without subscription paywalls. Some of it requires detailed knowledge of the field under study. That is why public understanding and non-academic output from researchers are also promoted as part of this document. Maximising the potential of the academic literature for aiding the achievement of SDGs, however, is clearly enhanced by removing at least one of the barriers to accessing it (the costs of subcrtiption).

Targets under SDGs 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 14, 15 and 17 are thus all identified as potentially benefiting from OA generally. Consider Goal 2: "End hunger, achieve food security and improved nutrition and promote sustainable agriculture". There already exists a signficiant literature in various subjects from biomedical science to agricultural science on issues as wide-ranging as child nutrition, crop rotation, sustainable multi-cropping approaches, etc. Goals 14 and 15 which focus on conservation of marine (14) and terrestrial (15) ecosystems are similarly areas where many of the target ecosystems are based in or near countries with underdeveloped economies. At present much useful research on ecological science, marine management, efficient water and waste treatment, is behind subscription paywalls and cannot be read by people in those countries and therefore cannot be applied to their situations

In particular, targets such as 3.b (Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries...), 5.6 (Ensure universal access to sexual and reproductive health and reproductive rights...) and 14.a (Increase scientific knowledge, develop research capacity and transfer marine technology...) would benefit from a move to OA/OD in a specific area of research (communicable diseases; reproductive biology and health; maritime science, respectively) which may or may not be more easily and quickly achievable than a move to a suitable open access approach across all fields.

Open Access: Access by Policy-makers/influencers

The history of OA and OD both began with a focus on the benefits to research of giving relatively unrestricted access to the processed inputs (data) and processed outputs (papers) of research to other researchers. As the movement promoting OA/OD has gathered pace other direct benefits to society of OA/OD have been put forward as extra arguments in favour of pressing forward with this change to the structure of researcher communications. One of these arguments is that although perhaps the vast majority of the world's population do not have the right background to understand most academic papers (most of which are written with a target audience of other experts in the field) there are people other than those specialist researchers who can make considerable socially-beneficial use of those papers, and many of them do not currently have the resources to pay subscription fees to access all the potentially useful papers. One highly important group for whom access is beneficial are those involved in making or influencing government policies. These range from elected representatives, elected or appointed ministers, civil servants, workers at chairities, members of think-tanks, and members of civil society groups. While some (particularly some think-tanks) are well- funded, many of these groups run on very limited budgets and while they have the intellectual ability to understand and make use of research papers, and sometimes research data, their budgets are often insufficient to pay subscription fees, while their lack of academic standing often precludes access to data (academic research projects will often share data with other academic research labs on request but are more wary of sharing with other groups for various reasons, unless they have made efforts to make their data suitable for OD release).
The RSSR explicitly acknowledges the importance of giving policy-makers/influencers improved access to research papers and data in Section IV. 16. (a). (v):

[It is the responsibility of researchers] to promote access to research results and engage in the sharing of scientific data between researchers, and to policy-makers, and to the public wherever possible

SDG 1 Target 1.a (Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions.) would be enhanced by improving access to the academic literature by policy-makers/influencers in countries with under-developed economies. In other RRING research, many policy-makers/influencers even in countries with developed economies commented that they do not have sufficient access to the academic literature to support their policy making/proposal work. These groups, given that they are almost all solely readers rather than writers of the research literature, would benefit from broader OA which reduced barriers to reading, even if such a move introduced barriers to publishing by researchers in their countries.

Open Access: Copyright, Patents, Design Rights

As noted in other RRING reports on OADS, the interplay between the openness of research in publishing its results as papers, sharing its processed data and encouraging others to build on their work with further research, with innovation and with practical implemetations, can come into conflict with the desire of researchers and their employers to secure some or all of the financial benefits that may derive from their work. The RSSR acknowledges this desire and the fact that various legal mechanisms exist to enable this: primarily some form of limited monopoly right over the outputs. The best-known examples of these monopoly rights being copyright, patents and design rights. Exercising these monopoly rights can be a problem in securing the best overall outcomes for society from important developments (a debate well beyond the scope of this document). The key point taken up in the RSSR is that the benefits to reserachers and their employers must be balanced against the potential benefits to society of not exerting all possible monopoly rights. This is recognised in the RSSR in Section IV. 18. (d):

Member states should help researchers to:
(d) in the context of their intellectual property regime, ensuring that contributions to scientific knowledge are appropriately credited, and balancing between protection of intellectual property rights and the open access and sharing of knowledge, as well as ensuring the protection of sources and products of traditional knowledge;

SDG 3, Targets 3.3, 3.5, 3.8 and 3.b, all being related to medical and biomedical science, in addition to potentially being helped by OA generally, could be helped by improvements in the issues of related rights in research being reformed. At present, just because something is published in the academic literature, does not mean it can be then freely used in innovation. Without getting into an argument about severely reducing those rights, the smaller step of ensuring that the research literature clearly marked such limitations would be a step forward. So, for example, SDG 3 Target 3.3 specifically mentions a number of commnicable diseases including AIDS and malaria as current epidemics which should be suppressed. As discussed by Mike (2020) pharmaceutical patents on medicines remain unbalanced between corporate profit and public health.

Open Access: Machine-reading

Related to the rights embedded in the contents of the literature itself, even where papers are accessible without subscription payment, the right to download papers in bulk and to process their contents into databases and then build upon that data remains somewhat restricted, although there are gradual moves to reduce or remove those restrictions (Molloy *et al.* 2016). While many areas of the SDGs could benefit from improvements in this area, the SDG targets mentioned just above (3.3, 3.5, 3.8 and 3.b) would be particularly eased by this move.

This concept is not explicitly supported in the RSSR, although the broad support for OA in the RSSR can be taken to include the ability to access the reserch literature on a mass scale paper at a time by human beings.

Open Access: OERs

Open Educational Resources (OERs) were an idea that was championed by lecturers at MIT in the early 2000s. As the birthplace of the Free Software Movement, MIT has long fostered the free sharing of information of many forms. The concept of OERs is that lecturers take their existing teaching materials, from syllabus descriptions to handouts, to lecture slides, to audio or audio/video recordings and make them freely available for re-use by other educators. In particular, much like the OD concept, the idea is not only to make something directly accesible in its original form, but to allow broad re-use to maximise the potential impact. There is a solid link to OA in that many university-level OERs build upon specific research papers. Access to the course materials develop by a lecturer and building upon a set of academic papers are not that useful if a lecturer re-using that material cannot then give their students access to the underlying papers. The concept of OERs can also be applied to primary, secondary and further education, although here the link to OA for academic research articles is less relevant.

SDG4 which focusses on education, and Target 4.1 (By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes.) which focusses on primary and secondary education, could benefit from improvements in open educational resources as well as by broader access to the education research literature on issues such as curriculum design.

The RSSR does not directly support OER production and dissemination, except in terms of promoting broader public understanding of the outcomes of research beyond the contents of academic papers (see next section).

Open Access: Public Understanding

Some of the debate about making research papers free to read is framed around giving access not (only) to other researchers but also to the general public (Day, Rennie, Luo & Tucker, 2020). Although OA removes one of the barriers to access experienced by the general public, other barriers remain. As noted above in the discussion about access by policy-makers, research papers are written with other researchers as their primary target audience. As such they generally assume readers are already familiar with various terminology, methodology and background concepts which is often not true for the general public. As other RRING research has shown, while OA is important and can aid public understanding of the outcomes of research, researchers themselves, both as a body and for some of them as individuals, should place more emphasis on ensuring public understanding of their results. The RSSR mentions this goal as a carefully delimited side effect of the primary OA goal of access by other researchers, the secondary goal of OA of access by policy-makers (see above) and, where possible, access by the public, in Section IV. 16. (a). (v)

[It is the responsibility of researchers] to promote access to research results and engage in the sharing of scientific data between researchers, and to policy-makers, and to the public wherever possible

SDG 16 Target 16.9 (Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements.) of course would benefit from OA in general, but improving the focus of ensuring that research results are not only published in the research literature but translated and presented in forms accessible to non- researchers would also help in achieving this target.

Open Access: Subscription Costs

OA is not solely about subscription costs (see above on the issues of patents and content mining) but a large part of the OA discussion rests on the current system of subscription payments by readers of the research literature and how to ensure that the funding streams to support the scholarly communication system are not removed by a move to OA. As discussed elsewhere in RRING's

reports the pay-to-read barrier is in danger of being supplemented by a pay-to-writer barrier while not even achieving the goal of a fully free-to-read system. The RSSR promotes researchers rights to publish their work in Sections V. 38 and 39. While these sections are primarily written in order to promote academic freedom and to reduce or eliminate governmental censorship of academic discourse, this also relates to the financial barriers to engaging in academic discourse. These barriers are currently primarily the lack of ability to pay subscription fees to read the academic literature by most researchers in countries with under-developed economies and even a sizeable minority of researchers in countries with developed economies. As noted in other RRING reports, there is a growing concern about the shift to author-fees simply replacing the pay-to-read barrier with a pay-to- write barrier.

SDGs 14 and 17, and the associated Targets 14.3 (Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels.) and 17.6 (Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing...) in particular are inhibited by the current situation with respect to subscription fees and are at risk if the move to pay-to-write is maintained.

Open Data: Direct

SDGs 6, 7, 14 and 17 with Targets 6.4, 7.a, 14.a and 17.8 are all targets whose achievement might be facilitated with more openness in research data. So, for example, SDG 6 Target 6.4:

By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

and SDG 7 Target 7.a:
By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology

involve improving efficiency in water and energy usage. As Killough (2018) points out for water management research, it is no longer a lack of data the is inhibiting improvements, but a lack of data being made available in a usable form. Pfenninger *et al.* (2017) makes a similar argument regarding data in the energy sector. In both of these cases, OD (the publication of underlying data sets by research projects) are an important issue but not the only one. In many cases easy and free access by researchers to suitable data sources (upstream data) is the key problem (see next section). The RSSR makes little mention of these issues, unfortunately.

Open Data: Upstream Data

While OD is usually focussed on ensuring that researchers make their data broadly available after taking their opportunity to analyse it (see other RRING reports on the issue of “right to first analysis” as a concern with possible implementations of OD rules) other RRING research also raised the problem that researchers have in gaining access to raw data in the purposes: political (social and demographics data); profit-making (energy data), etc. As noted by Pfenninger *et al.* (2017), however, the public benefit case for requiring such data to be freely available strongly outweighs any private benefit argument in most cases.
The broad availability of data on geographic, physical and social occurrences under open licenses which allow it to be used for scientific research, and for it both the original and processed data then to be made further available, is potentially useful for a number of SDGs/Targets. SDGs 1, 2, 3 and 7, specifically targets 1.5, 2.4, 3.3, 3.5, 3.8, 3.b, 3.9, 7.a, 17.20.
For example, SDG 2 Target 2.4:

By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

clearly benefits from the kind of data gathered by earth observation satellites (Killough, 2018) but access to this type of data is currently limited. These limitations are often not monetary in nature (i.e. it's not that the data is accessible but only at high cost). The problem is that this data is not set up to be broadly accessible and usable. Access is given on application and after consideration by its holders, and is it not processed so as to be most easily used in novel ways.

Open Science: Academic Freedom

Given its focus on researchers as well as the outputs of science, it is not surprising that the working conditions of scientists were a major focus. While improving the working conditions of scientists in general may help in achieving a number of the SDG Targets such as those involving North-South and South-South cooperation, two targets stand out as needing extra support in terms of protecting and enhancing academic freedom in order to be achieved. These are SDG 3 Target 3.5 (Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol.) and SDG 5 Target 5.6 (Ensure universal access to sexual and reproductive health and reproductive rights...). In both areas (substance abuse and reproductive health/medicine) social stigma, religious views and other social forces often place immense pressure on research funding and researchers to limit the kinds of work they can do and the kinds of views that policy-makers/influencers can access and use.

3. Recommendations

Improvements in Open Access, Open Data and Open Science would be useful in progress towards many of the SDG Targets. In most cases such issues are also supported by the RSSR which as noted above includes support for OADS both explicitly and implicitly.

Recommendations Related to OA

The move towards OA is gathering pace, albeit still too slowly to please many advocates. In addition, the move is being used by existing commercial publishers with already high profit margins (far exceeding almost any other commercial sector (McGuigan and Russell, 2008)) to embed these high profits and even to increase them. This is being done by initially introducing pay-to-write fees (author processing charges) either per-paper (in so-called Hybrid OA journals) or per-journal (by moving an existing journal from subscription to author-processing fees or by starting a new journal with this model). As noted above (and in other RRING reports on OA), the new pay-to-write barriers run the risk of continuing to pose problems for researchers in countries with under-developed economies, perpetuating their development difficulties and in particular the inefficiencies of their research and associated higher education systems and continuing the bran drain of some of their best researchers and educators to countries with already-developed economies. Governments, UNESCO and researchers themselves need to push publishers (whether existing commercial publishers, non-profit publishers[1] or new OA-based publishers into improving both the pay-to-read and the pay-to-write barriers for researchers in countries with under-developed economies.

The limited resources of the research funding bodies in those countries means that the income publishers stand to potentially receive from researchers in those countries is limited anyway, while the benefits that can be gained from providing free-to-read and free-to-write arrangements in achieving the SDG Targets is substantial.

Recommendation: Improve subscription access to the research literature for researchers in countries with under-developed economies.

On the free-to-read side, publishers should be pressured to provide broad access to all institutions in countries with under-developed economies at very low rates. Development agencies could pay for such access rights directly, providing scale of negotiation on behalf of the readers and ensuring that the funds are actually used for their intended purposes.

Recommendation: Negotiate blanket, well-defined and well-publicised fee waivers for research authors in countries with under-developed economies.

On the free-to-write side, publishers should be pressured into providing broad, well-defined fee waivers for researchers based in countries with under-developed economies. At present such waivers are negotiated on a per-country, per-publisher basis, and are often hard for researchers to know about.

Recommendation: Promote Swifter Movement to OA and OD in fields prioritised in various SDGs.

Biology (particularly plant-based food organisms), education, energy, medicine (specifically reproductive medicine and pharmaceuticals), marine science, transport, and water/waste science and engineering are all areas specifically highlighted in the SDGs for the achievement of targets which improvements in OA in these areas could support. These areas should be targetted by UNESCO and governments for action on improving the movement towards OA/OD. SDGs 2, 3, 4, 5, 6, 7, 11, 14,15 all need such a move.

Recommendation: Provide resources (funding and/or a platform) for regional repositories

The emergence of regional repositories such as ArabArxiv, which provides not only a central location where researchers based in a region can make their own work OA, but which also provide a platform for publication of OA journals for research about the region has already provided support for the achievement of SDG 17 Target 17.6. However, the funding for these repositories is uncertain and many are faced with closing to new deposits and merely archiving their existing material. UNESCO is probably best-placed to provide a replacement platform and to both fund it and continue to support it over the long term.

Recommendations Related to OD

Recommendation: Development projects should mandate open data where possible.

While not directly solving the problem of improving OD provision by researchers, improving the availability of public data in various areas such as energy consumption, natural resources (water, waste, raw materials, agricultural outputs) and demographic data would boost the research that can be undertaken in these areas. Governments in countries with under- developed economies and development agencies should recognise that the longer-term benefits of ensuring that development projects which produce such data make that data freely available are greater than any putative economic benefit from keeping the data private and privately exploitable. This is particularly relevant to SDGs 1, 2, 3, 6, 7, 14 and 17 under Targets 1.5; 2.4; 3.3; 3.5; 3.8; 3.b; 3.6.4;7.a; 14.3; 14.a; 17.20.

Recommendation: Provide a Worldwide Guide on OD in Medicine

The privacy issues around health data are recognised globally. However, so are the potential public health benefits of mass data availability. WHO, UNESCO, the Council of Europe and the OECD should be working together to build on the existing expertise of the OECD and the Council of Europe in such matters combined with the reach of UNESCO and the medical expertise of the WHO in developing guides for regulation of medical data to protect individuals and groups from misuse of their medical data while gaining the benefits worldwide of increased OD in medicine and bio-medical research.

SDG 3 Targets 3.8 and 3.b would be particularly aided by such a move.

Recommendations Related to OS

Recommendation: Overhaul the rights system in plant genetics and other aspects of seed stocks

In keeping with both the RSSR and the SDGs' aims, the current system of granting monopolies on seed stocks and other aspects of plant hybridisation is skewed towards the profits of large multi-national corporations and away from the indigenous populations whose local bio-resources often form the basis of new developments, and away from the groups in desperate need of new strains of food plants due to climate change, population pressure and other issues. UNESCO, WIPO and governments should recognise the current unfair system and work to balance the benefits with modest incentives to perform research. Prizes for innovation in areas of need (such as drought-resistant strains) may be a much better way to provide incentives than the current monopoly-granting system.

Recommendation: Strong action by UNESCO, WHO and governments in promoting Academic Freedom under the RSSR, particularly in the areas of Substance Abuse and Reproductive Health research.

Using the commitments to Academic Freedom in the RSSR, UNESCO, the WHO and governments should be promoting academic freedom generally, but specifically in the areas of substance abuse and reproductive health research, which have been highly politicised in recent decades.

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Chapter 5: Education and Scientific Careers

Inés Sánchez de Madariaga and Inés Novella Abril

1. Introduction

This report summarizes how the recommendations related to education included in the RSSR's terms on Education and Careers are relevant to the SDGs, and how they can help to implement the SDGs in a better, more responsible, and more inclusive ways.

The report identifies seven overall issues / themes that emerged from the coding/analysis of the RSSR, briefly explains in which ways each of these seven themes are relevant to which SDGs, and how each of them can contribute to better implementation of the identified SDGs.

The Report focusses on those SDGs in which education has a more direct and more fundamental impact, being well aware that knowledge generation and knowledge transfer, which is at the core of education, is required to all 17 SDGs. Decision making has to be evidence-based, and scientific education is needed for the implementation of all the SDGs.

2. Realization of Equal access to education and to scientific careers for all

This topic is relevant in the first place to:

SDG5 Gender Equality: Because of the gendered patters of gender inequality in science education and scientific employment, particularly in STEM areas. Women are a minority in STEM areas. In some continents and countries, a high percentage of women are forced to stop going to school in early adolescence. However, across fields of knowledge, in many parts of the world women are outperforming men and women represent a higher percentage of higher education graduates, up to 60% in many countries around the world.

SDG8 Inclusive growth for all: because jobs in areas related to an education in STEM fields are better paid and there is unfulfilled demand internationally.

SDG10 Reduced inequality within countries and among countries: because access to a science education brings employment opportunities to reduce inequality both within and among countries. Also because people in less developed countries have decreased opportunities for a science education and hence, less science educated persons to work in these sectors of the economy which are greater job generators.

Issues regarding gender gaps:

- For women: concentration in life-related fields and very few in STEM (horizontal segregation); concentration in lower level positions and few women in decision making and upper echelons (vertical segregation); overall smaller participation in the labor force. .
- Issues regarding men: increasing dropout rates of boys from secondary level education, and smaller participation overall in higher education than women.
- For women it is more an issue of employment and horizontal concentration in certain fields; for men it is more an issue of dropping out of education.

There is a need for action to develop:

- Policies that support young girls to continue in school after adolescence in those countries and continents where the dropout rate is high, particularly in Africa and many parts of Asia.
- Policies that support specifically women starting and completing degrees in STEM areas, across the world.
- Policies that support the advancement of women's careers and leadership positions.
- Policies that support vocations in STEM for all, also for men, as there is a need for more graduates in these areas across the world. These policies should be particularly strenghthened in less developed countries.
- Policies to support men completing higher education degrees in those continents and countries in which the rate of men graduates is significantly lower than that of women across fields of study (such as Europe and Latin America).
- Ensure that, without discrimination on the basis of race, colour, descent, sex, gen- der, sexual orientation, age, native language, religion, political or other opinion, national origin, ethnic origin, social origin, economic or social condition of birth, or disability, all citizens enjoy equal opportunities for the initial education and training needed to qualify for research and development careers, as well as ensuring that all citizens who succeed in so qualifying enjoy equal access to available employment in scientific research;

3. Ensuring mobility in education and research (geographical and across sectors of employment including higher education)

This topic is relevant to:

SDG5, because mobility for women is more difficult because of family responsibilities, so mobility needs to be addressed with a gender perspective.

SDG 10, because countries less developed have less resources to send their students abroad and also face higher risks of brain drain when they go outside to study.

There is a need for action to develop:

Policies to proper funding mobility of students and researchers

(i) Gender responsive measures in the design of mobility schemes, including in future pensions and in fiscal implications, as well as in family-related considerations. This has to be designed at national level as it involves national ministries beyond and in addition to the ones responsible for research and education (ie ministries in charge of pension policies, fiscal policy, etc). It is a highly complex issue.

(ii) Measures to prevent brain drain, i.e., encourage those scientific researchers (or young people who aspire to become scientific researchers) who seek some of their education, training or experience abroad, to return and to work in their country.

(iii) Measures to incentivise changing employment sectors. Member States should enable and facilitate mobility of scientific researchers between public sector, private sector and higher education employment, as well as outside of research and development

Different actors as primary areas of action:

- National policy making: regulation and funding. actions recommended to governments include:
- With regard to mobility of scientific researchers between research and development and other public functions. Member States should particularly: provide procedures for the

periodic review of the material conditions of scientific researchers to ensure that they remain equitably comparable with those of other workers having equivalent experience and qualifications and in keeping with the country's standard of living; introduce conditions of employment specially designed for scientific researchers benefitting from this mobility; and provide the scientific researchers benefitting from this mobility with adequate career development prospects

- International policy and funding organisations: directions, recommendations.
- Funding bodies: programs, funding and regulations
- Research performing organizations and universities: implementation
- Research projects: implementation

4. Ensuring Ethics Are addressed into the education of scientists, both in terms of content and educational techniques.

This is relevant to all SDGs and is a topic that interrelates two RRI themes: education and ethics. The ethics team will be addressing it directly as their main topic.

Action to be taken towards establishing suitable means to address the ethics of science and of the use of scientific knowledge and its applications, specifically through establishing, promoting and supporting independent, multidisciplinary and pluralist ethics committees in order to assess the relevant ethical, legal, scientific and social issues related to research projects involving human beings, to provide ethical advice on ethical questions in research and development, to assess scientific and techno- logical developments and to foster debate, education and public awareness and engagement of ethics related to research and development. Each domain's curricula and courses should integrate the ethical dimensions of science and of research.

As far as ethics interrelate to education and in relationship to all the SDG, the most relevant issue is the importance that particularly the Humanities and also the Social Sciences must have in the education of persons. The Humanities must keep an important role in education at all levels, particularly in primary and in secondary education. At the higher education level, the education of scientists and technologist must also include a relevant component of the curricula courses on the Humanities and in Social Sciences.

Policies must be developed to ensure that the Humanities are kept with a sufficient teaching load in the curricula at all levels of education.

Regarding educational techniques, action to address ethics can include:

- develop and use educational techniques for awakening and stimulating such personal qualities and habits of mind as:
    - intellectual integrity, sensitivity to conflict of interest, respect for ethical principles pertaining to research;
    - the ability to review a problem or situation in perspective and in proportion, with all its human implications;
    - skill in isolating the civic and ethical implications, in issues involving the search for new knowledge and which may at first sight seem to be of a technical nature only;

5. Realizing socially and environmentally responsible science

This is relevant to all SDGs in a rather obvious way, as science provides the knowledge on which to build the policies and actions to support socially and economic and environmentally sustainable development.

Member States should take measures to encourage the spirit of service both to the advancement of science and to social and ecological responsibilities toward their fellow nationals, humanity in general, future generations, and the earth including all its ecosystems, its sustainable development and its conservation, as an important element in their education and training.

Educational and research institutions should:

- develop and use educational techniques for awakening and stimulating such personal qualities and habits of mind as: (…)
- vigilance as to the probable and possible social and ecological consequences of research and development activities.

5. Increasing the numbers of STEM graduates

This topic relates to SDG5 because there is a lack of women in STEM areas and also to SDG 10, reduced inequality within and among countries. See comments for #1 above.

Reduced STEM vocations is a problem in many parts of the world. STEM careers are difficult and burdensome; for women they might look a bit “freaky” or not addressing social issues.

There is a need for action to incentivise vocations:

They should make STEM careers more attractive. Addressing the image of STEM careers can contribute to increase vocations, particularly women’s, when they are presented as careers that contribute to societal wellbeing and environmentally sustainable development. Vocations are defined in early childhood, according to scientific literature often before the age of 7. So action is needed on the part of parents and in primary schools so that girls and boys are attracted to STEM areas in their early years. Programs in secondary school will also be useful, aswell as mentoring programs in collaboration with employers.

Some specific measures:

- National policy making: regulation and funding. Should aim at strengthen all sciences, technology, engineering and mathematics education, in schools and other formal and informal settings.
- International policy and funding organisations: directions, recommendations.
- Funding bodies: programs, funding and regulations
- Research performing organizations and universities: implementation
- Research projects: implementation

6. Beyond science: interdisciplinarity, arts, business & communication to non-scientific audiences

This relates to SDG 16 and SDG17, as everything dealing with stakeholder participation, alliance building, justice for all, and the like, requires that scientific knowledge be spoken in the language of lay people for everyone to understand, using even communication means such as artistic

manifestations that appeal to other, non-scientific, ways of understanding the world, such as art or poetry.

Educational institutions should develop and use educational techniques for awakening and stimulating such personal qualities and habits of mind as the willingness to communicate with others not only in scientific and technological circles but also outside those circles, which implies willingness to work in a team and in a multi-occupational context.

They should also incorporate interdisciplinary and art and design elements in curricula and courses of all sciences as well as skills such as communication, leadership and management.

There is a need for action with art and science museums, with the media, and with the movie industry to reach out to everyone and to foster complex ways of knowledge that can complement and enrich science.

7. Access to publications, data and other resources, and lifelong education of scientists

This relates to SDG4 regarding lifelong learning which is again a challenge in terms of equality and quality of such training, so it again intermingles with SDG5 SDG10 SDG8.

This also directly interrelates with the Open access RRI topic with which ir very much overlaps.

Member States should encourage that facilities be provided so that scientific researchers enjoy lifelong opportunities for keeping themselves up to date in their own and in other scientific fields, by attendance at conferences, by free access to international databases and journals, libraries and other sources of information, and by participation in training.

Member states and institutions should put in place policies aiming to facilitate that the scientific researchers freely develop and contribute to sharing data and educational resources, for example by means of virtual fora.

Chapter 6: Human Rights

Niharika Kaul and Achim Rosemann

1. Introduction

This report examines the human rights dimensions in the UNESCO's Recommendation on Science and Scientific Researchers (RSSR). The aim of the report is to reflect on (i) the ways in which the RSSR's commitment to human rights can be mapped onto and actively applied in the context of science-based strategies to realise specific SDGs, and (ii) how a commitment to human rights norms can be strengthened in the context of national and international research and development activities that emerge in relation to the SDGs.

To achieve these aims, the report is structured in three parts.

- Section 2.1., which discusses relevant text passages in the RSSR that refer to human rights, either directly or indirectly.
- Section 2.2., in which human rights and human rights-related recommendations in the RSSR are linked to the SDGs, both at a more general level, and at the level of individual SDGs.
- Section 3., which provides a set of recommendations that spell out how the human rights-dimensions of the RSSR can be applied to science and technology-based solutions to achieve the SDGs.

Because references to human rights in the RSSR are often rather general, we base part of our discussion on the definitions of human rights as spelled out in:

- The Universal Declaration of Human Rights (1848) (UDOHR)
- The Convention for the Protection of Human Rights and Dignity of the Human Being with regard to the Application of Biology and Medicine (Council of Europe, 1997) (The Convention, 1997)
- Additional Protocol to the American Convention on Human Rights in the Area of Economic, Social and Cultural Rights (1988) (Additional Protocol, 1988)
- Universal Declaration on the Human Genome and Human Rights (UNESCO, 1997) (UDOHGHR)
- Universal Declaration on Bioethics and Human Rights (UNESCO, 2005) (UDOBHR)
- International Covenant on Civil and Political Rights 1976 (ICCPR 1976)
- International Covenant on Economic, Social and Cultural Rights 1976 (ICESC 1976)
- WMA Declaration Of Helsinki – Ethical Principles For Medical Research Involving Human Subjects, Last Amended In 2013 (WMA Declaration, 2013)
- International Ethical Guidelines for Health-related Research Involving Humans, 2016 (International Ethical Guidelines, 2016)

2. Results

2.1. Results theme-specific analysis of RSSR

This section provides an overview of text passages in the RSSR that refer to human rights, either directly or indirectly. Section 2.1.1. introduces a number of broad, general references to human rights in the RSSR. We will briefly discuss these passages and clarify to which human rights these passages refer to.

Then, in section 2.2. we discuss more specific references to human rights. These are either, direct references to individual human rights, or indirect references that allude to human rights, but without mentioning them directly. For these indirect human rights references we discuss first to which human rights the RSSR refers, then explain their significance for scientific researchers and in the context of scientific research and development activities. In order to avoid overlap with other teams in Task 6.1 (especially the work of the "Science Education and Scientific Careers" team, as well as the "Open Access and Open Data" team), we have selected four key areas of scientific research and development, in which we think recognition of human rights is especially important. These will be introduced at the start of Section 2.1.2.

2.1.1. General References to Human Rights in the RSSR

General references to human rights in the RSSR were made with regard to four overarching themes: (i) The use of science to the detriment of human rights; (ii) the responsibility of researchers to prevent that scientific research undermines human rights; (iii) the responsibilities of institutions, people and organizations that fund, guide or govern research; and (iv) awareness of possible human rights violations in the context of international research. Each of these points, and the human rights that are relevant in the context of these themes, are now discussed.

The use of science to the detriment of human rights

The RSSR mentions in its Preamble, that "scientific discoveries and related technological developments and applications […] can be used to the detriment of human rights", and vital human interests, including to the detriment of "fundamental freedoms", and "the dignity of a human person" (Preamble).

This text passage refers to a broad range of human rights as defined in the UDOHR 1848. These include, for example:

- Article 1, right of "humans [to be] free and equal in dignity", and to "act towards one another in a spirit of brotherhood"
- Article 3, "everyone has the right to life, liberty and security of person"
- Article 5, "no one shall be subjected [to] cruel, inhuman or degrading treatment"
- Article 7, "All are equal before law" and "deserve [without discrimination] equal protection of the law"
- Article 12, right of humans to be protected from "interference with privacy, family, home or correspondence",
- Article 13, "the right to freedom of movement and residence" (which the RSSR addressed separately, see below)
- Article 18, "the right to freedom of thought, conscience and religion"
- Article 19, "right to freedom of opinion and expression"
- Article 20, "right to freedom of peaceful assembly and association"

- Article 21, “right to take part in the government of [one’s] country, directly or through freely chosen representatives”, and “the right to equal access to public service”
- Article 22, “right to social security” and protection of “the economic, social and cultural rights indispensable for [the] dignity [of a person], and the free development of his [and her] personality”
- Article 23, “the right to work and free choice of employment” (this is also separately discussed in the RSSR, and is also reflected in SDG 8)
- Article 25, “right to a standard of living adequate for the health and well-being” of individuals, families and communities, as well as “special care and assistance [for] motherhood and childhood”
- Article 26, “the right to education” (another key theme in the RSSR, and reflected in SDG 4)
- Article 27, “the right [to] freely […] participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement”

Scientific research and the application of scientific discoveries can in principle result in violations to each of the human rights mentioned here. This also includes science and technology research that aims to facilitate the implementation of the SDGs. While some of the human rights listed above (for example Article 23 on the right to work, or Article 26 on the right to education) are reflected in individual SDGs (e.g., SDG4 on education, and SDG8 on economic growth and decent work for all), this does not automatically prevent possible breaches of these and other human rights in the context of the application of science for other SDGs.

The responsibility of researchers to prevent that scientific research undermines human rights

Another general reference to the human rights, as a broad category, is made in Point 16 of the RSSR, that discusses the rights and responsibilities of scientific researchers. This section mentions that scientific researchers have a “right to express themselves freely and openly on the ethical, human, scientific, social or ecological value of certain projects, and in those instances where the development of science and technology undermine human welfare, dignity and human rights or is ‘dual use’, they hae the right to withdraw from those projects…”

The below text passage refers to the human rights pertaining to free speech and expression which are pertinent in this context-

- Article 1, UDOHR 1848 ‘Right [to be] free and equal in dignity’ and right to ‘act towards one another in the spirit of brotherhood’
- Article 18, UDOHR 1848 “Right to freedom of thought, conscience and religion”
- Article 19, UDOHR 1848 the “Right to freedom of opinion and expression”
- Article 2, The Convention 1997, “Primacy of the human being”
- Article 10, UDOHGHR 1997, “No research or research applications concerning the human genome… should prevail over respect for the human rights, fundamental freedoms and human dignity of individuals”
- Article 21, UDOHGHR 1997 “Free expression of various sociocultural, religious and philosophical opinions”
- Article 18, UDOBHR 2005, “Opportunities for informed pluralistic public debate, seeking the expression of all relevant opinions, should be promoted.”
- Article 19, ICCPR 1976, “Right to freedom of expression”

RSSR articulates the need for scientists to have the freedom to express their views on ethical, human, scientific, social or ecological value of certain projects as well as on those where the human

welfare, dignity or human rights are in question. It affirms that all individuals have a right to withdraw freely from such projects where their conscience so dictates. In this context, the first right that becomes relevant here is the right to be free and equal individuals and enjoy the same dignity and respect to make their own decisions for personal and professional purposes. A related right that flows from this is the right to be able to freely express one's thoughts and opinions. No form of scientific research can take precedence over the individual's basic right to question existing scientific research and practices and voice their opinions and criticisms about the same. This right opens doors for encouraging public debate and dialogue for democratic participation in science and innovation. Finally, the right to primacy of human beings, where in the interests and welfare of the human beings shall prevail over the sole interest of society or science is of particular importance. This is because it gives priority to every human being's welfare, health and dignity over all other goals that science aims to achieve for collective good.

The responsibilities of institutions, people and organizations that fund, guide or govern research

Another section in which the RSSR makes a general reference to human rights, is in Point 20, which defines the responsibilities of institutions, people and organizations that fund, guide or govern scientific research and its applications. The RSSR states in this regard that: "Member States should endeavour to ensure that research and development undertaken, funded, or otherwise pursued in whole or in part in different States, is consistent with principles of conducting research in a responsible manner that respects human rights. In particular, for transnational research involving human subjects" (20)

The below -mentioned human rights are relevant in the context of ethical considerations, participation in science in the national and transnational context:

- Article 5, UDOHGHR 1997, "(a) Research, treatment or diagnosis affecting an individual's genome shall be undertaken only after rigorous and prior assessment of the potential risks and benefits pertaining thereto and in accordance with any other requirement of national law."
- "(b) In all cases, the prior, free and informed consent of the person concerned shall be obtained. If the latter is not in a position to consent, consent or authorization shall be obtained in the manner prescribed by law, guided by the person's best interest."
- "(c) The right of each individual to decide whether or not to be informed of the results of genetic examination and the resulting consequences should be respected."
- "(d) In the case of research, protocols shall, in addition, be submitted for prior review in accordance with relevant national and international research standards or guidelines."
- "(e)Research which does not have an expected direct health benefit may only be undertaken by way of exception"
- Article 8, UDOHGHR 1997, "Every individual shall have the right, according to international and national law, to just reparation for any damage sustained as a direct and determining result of an intervention affecting his or her genome."
- Article 10, UDOHGHR 1997, "No research or research applications concerning the human genome, in particular in the fields of biology, genetics and medicine, should prevail over respect for the human rights, fundamental freedoms and human dignity of individuals or, where applicable, of groups of people."
- Article 11, UDOHGHR 1997, "Practices which are contrary to human dignity, such as reproductive cloning of human beings, shall not be permitted."
- Article 15, UDOHGHR 1997, "[States] should seek to ensure that research results are not used for non-peaceful purposes."

- Article 16, UDOHGHR 1997, “States should recognize the value of promoting, at various levels, as appropriate, the establishment of independent, multidisciplinary and pluralist ethics committees”
- Article 2, UDOBHR 2005, “(d) to recognize the importance of freedom of scientific research and the benefits derived from scientific and technological developments, while stressing the need for such research and developments to occur within the framework of ethical principles set out in this Declaration and to respect human dignity, human rights and fundamental freedoms”
- “(e) to foster multidisciplinary and pluralistic dialogue about bioethical issues between all stakeholders and within society as a whole”;
- “(f) to promote equitable access to medical, scientific and technological developments as well as the greatest possible flow and the rapid sharing of knowledge concerning those developments and the sharing of benefits, with particular attention to the needs of developing countries”;
- “(g) to safeguard and promote the interests of the present and future generations”
- Article 4, UDOBHR 2005, “In applying and advancing scientific knowledge, medical practice and associated technologies, direct and indirect benefits to patients, research participants and other affected individuals should be maximized and any possible harm to such individuals should be minimized.”
- Article 6, UDOBHR 2005 “1. Any preventive, diagnostic and therapeutic medical intervention is only to be carried out with the prior, free and informed consent of the person concerned, based on adequate information. The consent should, where appropriate, be express and may be withdrawn by the person concerned at any time and for any reason without disadvantage or prejudice.”
- “2. Scientific research should only be carried out with the prior, free, express and informed consent of the person concerned.”
- “3. In appropriate cases of research carried out on a group of persons or a community, additional agreement of the legal representatives of the group or community concerned may be sought. In no case should a collective community agreement or the consent of a community leader or other authority substitute for an individual’s informed consent.”
- Article 7, UDOBHR 2005, “In accordance with domestic law, special protection is to be given to persons who do not have the capacity to consent”
- Article 14, UDOBHR 2005, “1. The promotion of health and social development for their people is a central purpose of governments that all sectors of society share.”
- Article 18, UDOBHR 2005, “1. Professionalism, honesty, integrity and transparency in decision-making should be promoted, in particular declarations of all conflicts of interest and appropriate sharing of knowledge.”
- Article 19, UDOBHR 2005, “Independent, multidisciplinary and pluralist ethics committees should be established, promoted and supported at the appropriate level”
- Article 21, UDOBHR 2005, “1. States, public and private institutions, and professionals associated with transnational activities should endeavour to ensure that any activity within the scope of this Declaration, undertaken, funded or otherwise pursued in whole or in part in different States, is consistent with the principles set out in this Declaration.”
- “2. When research is undertaken or otherwise pursued in one or more States (the host State(s)) and funded by a source in another State, such research should be the object of an appropriate level of ethical review in the host State(s) and the State in which the funder is located. This review should be based on ethical and legal standards that are consistent with the principles set out in this Declaration.”

- "3. Transnational health research should be responsive to the needs of host countries, and the importance of research contributing to the alleviation of urgent global health problems should be recognized."
- "4. When negotiating a research agreement, terms for collaboration and agreement on the benefits of research should be established with equal participation by those party to the negotiation."
  "5. States should take appropriate measures, both at the national and international levels, to combat bioterrorism and illicit traffic in organs, tissues, samples, genetic resources and genetic-related materials."
- Preamble, The Convention, 1996, "Affirming that progress in biology and medicine should be used for the benefit of present and future generations;"
- Article 5, The Convention, 1996, "An intervention in the health field may only be carried out after a person concerned has given free and informed consent to it."
- Article 6, The Convention, 1996, "Protection of persons not able to consent"
- Article 15, The Convention, 1996, "Scientific research in the field of biology and medicine shall be carried out freely, subject to the provisions of this Convention and the other legal provisions ensuring the protection of the human being."
- Article 16, The Convention, 1996, "Protection of persons undergoing research"
- Article 17, The Convention, 1996, "Protection of persons not able to consent to research"
- Guideline 1, International Ethical Guidelines, 2016, "Scientific and social value and respect for rights"
- Declaration 7, WMA Declaration, 2013, "Medical research is subject to ethical standards that promote and ensure respect for all human subjects and protect their health and rights"
- Declaration 8, WMA Declaration, 2013, "While the primary purpose of medical research is to generate new knowledge, this goal can never take precedence over the rights and interests of individual research subjects." (A research subject referred to in this document refers to a participant in a research study; where the study can go beyond medical research)

The aforesaid passage from the RSSR refers to ethical and moral aspects concerning research conducted across States. The first right that flows from it is to recognize the ethical framework and principles based on which scientific research must be conducted in order to remain responsible. The root of this requirement for ethical frameworks is the 'public benefit' aspect of scientific and technological developments. To facilitate this, pluralist ethics committees must be established and supported across all levels of state functioning. With specific regard to human genome research, research, treatment or diagnosis shall be conducted after a comprehensive and thorough assessment of risks and benefits that can potentially emerge from that research. The harms of the scientific intervention must be minimised while the benefits to the individual research participants must be maximised.

The right to full participation of relevant communities is an equally important aspect. This refers to informed participation and access to results of the scientific research conducted of which they were a part. Consenting to becoming a part of the scientific interventions is critical. Individuals have a right to prior, free and informed consent which can be expressed or withdrawn anytime for any reason from a medical intervention or any scientific research. In no case can the consent of a community leader substitute free and informed consent of individual members. Individuals who undergo genetic examination have a right to free and informed consent to such examination and the resulting consequences must be respected Special protection is also granted to those who are incapable of consent, since they are most vulnerable to being taken advantage of for a scientific intervention. In terms of accessing the results, equitable access to the results of the scientific

developments and rapid sharing of knowledge are especially important, specifically with regard to developing countries.

Transparent and integrity-based mechanisms must be developed for decision- making. The purpose for which scientific research is conducted is therefore the central point for making science responsible. Scientific developments and results of the research must only be used for peaceful purposes. Promotion of health is a critical component of scientific research and development that Governments must actively ensure. Although medical research has its primary goal as generation of new knowledge, the goal can never take precedence over rights and interests of individual research participants. With specific regard to human genome-related interventions, research which does not have expected direct health benefit may only be undertaken as an exception.

Transnational research should be particularly responsive to the requirements of the host country, to ensure protection of research participants and recognise the importance of addressing global health problems. Parties to the cross-border research must have an equal say in the terms of the agreement to conduct the research in order to ensure equitable methods of conducting the research. States should establish strict and accountable mechanisms for countering biopiracy, bioterrorism and illicit trafficking of organs, tissues and genetic – related materials.

Awareness of possible human rights violations in the context of international research

Still another section in which the RSSR refers to human rights at a more general level, is under Point 18, on International research and international research collaborations. The RSSR mentions that: “Member States should recognize the international dimensions of research and development and, in this regard, should do everything possible to help scientific researchers, including, “taking measures [that are] ensuring the protection of the human rights, fundamental freedoms and dignity of the human person, and the confidentiality of personal data”.

The below mentioned human rights are pertinent and deserve protection in the context of cooperation between scientists across borders on contributing to the body of scientific knowledge, confidentiality and giving due credit to those individuals or communities who have created any scientific discovery.

- Article 17, ICCPR, 1976, “1. No one shall be subjected to arbitrary or unlawful interference with his privacy, family, home or correspondence, nor to unlawful attacks on his honour and reputation.”
- Article 12, UDOHR 1848 “No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence”
- Preamble, The Convention, 1996, “Stressing the need for international co-operation so that all humanity may enjoy the benefits of biology and medicine”
- Article 10, The Convention, 1996 “Private life and right to information”
- Article 7, UDOHGHR 1997, “Genetic data associated with an identifiable person and stored or processed for the purposes of research or any other purpose must be held confidential in the conditions set by law.”
- Article 8, UDOHGHR 1997, “Every individual shall have the right, according to international and national law, to just reparation for any damage sustained as a direct and determining result of an intervention affecting his or her genome.”
- Article 9, UDOHGHR 1997, “In order to protect human rights and fundamental freedoms, limitations to the principles of consent and confidentiality may only be prescribed by law, for

compelling reasons within the bounds of public international law and the international law of human rights."

- Article 11, UDOHGHR 1997, Practices which are contrary to human dignity, such as reproductive cloning of human beings, shall not be permitted. States and competent international organizations are invited to co-operate in identifying such practices and in taking, at national or international level, the measures necessary to ensure that the principles set out in this Declaration are respected.
- Article 17, UDOHGHR 1997, States should respect and promote the practice of solidarity towards individuals, families and population groups who are particularly vulnerable to or affected by disease or disability of a genetic character. They should foster, inter alia, research on the identification, prevention and treatment of genetically based and genetically influenced diseases, in particular rare as well as endemic diseases which affect large numbers of the world's population
- Article 19, UDOHGHR 1997, "(b) Relevant international organizations should support and promote the initiatives taken by states for the above-mentioned purposes."
- Preamble, UDOBHR 2005, "Stressing the need to reinforce international cooperation in the field of bioethics, taking into account, in particular, the special needs of developing countries, indigenous communities and vulnerable populations"
- Article 9 UDOBHR 2005, The privacy of the persons concerned and the confidentiality of their personal information should be respected. To the greatest extent possible, such information should not be used or disclosed for purposes other than those for which it was collected or consented to, consistent with international law, in particular international human rights law.
- Article 13, UDOBHR 2005, "Solidarity among human beings and international cooperation towards that end are to be encouraged"
- Article 15, UDOBHR 2005, "1. Benefits resulting from any scientific research and its applications should be shared with society as a whole and within the international community, in particular with developing countries."
- Article 21, UDOBHR 2005, "Transnational practices"
- Article 14, Additional Protocol, 1988, "Right to the Benefits of Culture"
- Declaration 9, WMA Declaration, 2013 "It is the duty of physicians who are involved in medical research to protect the life, health, dignity, integrity, right to self-determination, privacy, and confidentiality of personal information of research subjects."

This passage from the RSSR raises three fundamental human rights. The first is the right that recognises the need for international co-operation between States to ensure that all of humanity enjoys the benefits of biology and medicine. This can allow scientists all over the world to share resources/infrastructure and knowledges, and maximise scientists' potential for conducting scientific research and innovation. Cooperation and collaboration is a key component for true scientific advancement to take place.

The second right that requires protection in this context is the right to confidentiality. No individual must be subject to unlawful interference with their privacy and information that is confidential for them. Limitations to privacy and confidentiality may only take place for compelling reasons in congruence with international human rights laws. Genetic data associated with a person which may be acquired and stored for scientific research must be held confidential in conditions set by law to ensure it is not interfering with their privacy and so that it is not misused. Damages caused by such interference with their genome deserve reparation.

Intellectual property rights also require protection for giving due credit to any person's scientific discovery. This right extends to local communities and indigenous communities that possess rich knowledge about myriad aspects of life but do not have this knowledge codified in scripts or written texts according to western standards of codification. This allows many scientific researchers and experts to steal their knowledge without giving them due credit for contributing the same.

2.1.2. More specific references to Human Rights in the RSSR

2.1.2.1 Direct references to human rights in the RSSR

Several terms in the RSSR make direct references to individual human rights. These are as follows:

Sharing in scientific advancements and its benefits

The Preamble of the RSSR mentions "the right freely to participate in the cultural life of the community, and to share in scientific advancement and its benefits (Preamble). Point 21 states, that: "So as to ensure the human right to share in scientific advancement and its benefits, Member States should establish and facilitate mechanisms for collaborative open science and facilitate sharing of scientific knowledge while ensuring other rights are respected.

Article 12, UDOHGHR 1997, "(a) Benefits from advances in biology, genetics and medicine, concerning the human genome, shall be made available to all, with due regard for the dignity and human rights of each individual."

"(b) Freedom of research, which is necessary for the progress of knowledge, is part of freedom of thought. The applications of research, including applications in biology, genetics and medicine, concerning the human genome, shall seek to offer relief from suffering and improve the health of individuals and humankind as a whole."

Article 15, UDOBHR 2005, "Sharing of benefits"

The right to share results emerging from scientific research assumes critical importance both for the survival and betterment of the public at large, as well as for the advancement of science itself. Scientific advancement can truly only take place when it is inclusive and representative of diverse knowledges and cultures. Local communities, indigenous communities and the general public have the right to contribute to, not just be passive recipients of scientific developments.

The right to health and well-being

Point 22 in the RSSR uses the right to health as a basis to promote benefit sharing and broad public access to medical advancements: "So as to ensure the human right to health, Member States should take measures so that benefits resulting from any research and its applications are shared with society as a whole and within the international community, in particular with developing countries"

The below-mentioned human rights are in this particular context of right to health-

Article 25, UDOHR, "1.Every one has the right to a standard of living adequate for the health and well-being of himself and of his family"

Article 10, Additional Protocol, 1988, "Right to Health"

Universal Declaration on Bioethics and Human Rights 2005

Article 14 , UDOBHR 2005, "2. Taking into account that the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being…"

Article 10, The Convention, 1997, “Private life and right to information”

Right to health is extremely relevant in the context of responsible research because it is this aspect of science that forms the foundation of the study and practice of science. Only when right to health is recognised and implemented at the community level will the public at large be able to access the benefits of the scientific developments.

2.1.2.2. Indirect references to human rights in the RSSR

Several themes in the RSSR make indirect references to human rights. These are as follows:

Education, Training and Employment of Scientific Researchers

The following passages from the RSSR suggest the protection of rights of researchers in the realm of education, as well as employment. Point 13 states that (a) ensure that, without discrimination on the basis of race, colour, descent, sex, gender, sexual orientation, age, native language, religion, political or other opinion, national origin, ethnic origin, social origin, economic or social condition of birth, or disability, all citizens enjoy equal opportunities for the initial education and training needed to qualify for research and development careers, as well as ensuring that all citizens who succeed in so qualifying enjoy equal access to available employment in scientific research; (b) abolish inequalities of opportunities; (c) in order to remediate past inequalities and patterns of exclusion, actively encourage women and persons of other under-represented groups to consider careers in sciences, and endeavour to eliminate biases against women and persons of other under-represented groups in work environments and appraisal;

- In terms of employment rights, Point 27 states that “Member States should develop policies with respect to employment that adequately cover the needs of scientific researchers, in particular by: (a) providing scientific researchers in their direct employment with adequate career development prospects and facilities, including but not limited to research and development”
- Point 29 states that [Member States should] “(b) introduce conditions of employment specially designed for scientific researchers benefitting from this mobility”
- Point 40 states that “Member States should adopt the following standard practices: (a) written provisions to be included in the terms and conditions of employment of scientific researchers, stating clearly what rights (as applicable) belong to them (and, where appropriate, to other interested parties) in respect of their contributions to any discovery, invention, or improvement in technical knowhow or commercialization which may arise in the course of or as a result of the research and development that those scientific researchers undertake;”
- Point 41 states that “They should therefore see to it that all texts setting out terms of employment for, or governing the conditions of work of scientific researchers, be framed and interpreted with all the necessary flexibility to meet the requirements of research and development”
- Point 42 suggests that “Member States should recognize it as wholly legitimate, and indeed desirable, that scientific researchers should associate to protect and promote their individual and collective interests, in bodies such as trade unions, professional associations and learned societies, in accordance with the rights of workers in general and inspired by the principles set out in the international instruments listed in the annex to this Recommendation. In all cases where it is necessary to protect the rights of scientific

researchers, these organizations should have the right to support the justified claims of such researchers."

- The below mentioned human rights must be protected in the context of education, training and employment opportunities.
- Article 23, UDOHGHR 1997, "States should take appropriate measures to promote, through education, training and information dissemination, respect for the above-mentioned principles and to foster their recognition and effective application."
- Article 22, UDOBHR 2005, "1. States should take all appropriate measures, whether of a legislative, administrative or other character, to give effect to the principles set out in this Declaration in accordance with international human rights law. Such measures should be supported by action in the spheres of education, training and public information."
- "2. States should encourage the establishment of independent, multidisciplinary and pluralist ethics committees, as set out in Article 19."
- Article 23, The Convention, 1997, "1... States should endeavour to foster bioethics education and training at all levels as well as to encourage information and knowledge dissemination programmes about bioethics."
- Article 13, ICESCR 1976 "1. The States Parties to the present Covenant recognize the right of everyone to education….They further agree that education shall enable all persons to participate effectively in a free society, promote understanding, tolerance and friendship among all nations and all racial, ethnic or religious groups, and further the activities of the United Nations for the maintenance of peace."
- Article 23, UDOHR 1848, "1.Everyone has the right to work, to free choice of employment, to just and favourable conditions of work and to protection against unemployment."
- Article 7, Additional Protocol 1988, "Just, Equitable, and Satisfactory Conditions of Work"
- Article 7, ICESR 1976, "The States Parties to the present Covenant recognize the right of everyone to the enjoyment of just and favourable conditions of work"

Education and training of researchers at all levels, starting from young researchers onwards is imperative for improving the standards of scientific research. Education and training allow scientists to be exposed to many different opportunities within the field of scientific research and development. The right to education and training also recognises the different skill sets acquired through training, which evolve with time and with new technologies. Right to education must be irrespective of various differences between individuals based on gender, race, religion, caste, class, and so on and so forth. Every human deserves an equal and equitable right to education and training to enhance their career opportunities and improve their livelihoods. Right to employment is fundamental to an individual's self- worth and dignity. More importantly, social protection, fair and equal treatment and safety mechanisms must be woven within the fabric of the work environment within the science field. Workers right to dignified and decent life is crucial even for the scientists' own potential to be maximised. Although within the aforesaid passage in the RSSR on the

Ecology, climate science and sustainable development

In the RSSR, the following passages encourage the protection of ecology through the spirit of service. Point 13 states that "To assist the emergence of scientific researchers of this high calibre, Member States should take measures to: (d) encourage the spirit of service both to the advancement of science and to social and ecological responsibilities toward their fellow nationals, humanity in general, future generations, and the earth including all its ecosystems, its sustainable development and its conservation, as an important element in their education and training"

The below-mentioned rights must be protected in order to inculcate the values of sustainable development and ecology within the realm of science.

Article 14, UDOBHR 2005,

“2. Taking into account that the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition, progress in science and technology should advance:(c) improvement of living conditions and the environment”

Article 17, UDOBHR 2005,

“Due regard is to be given to the interconnection between human beings and other forms of life, to the importance of appropriate access and utilization of biological and genetic resources, to respect for traditional knowledge and to the role of human beings in the protection of the environment, the biosphere and biodiversity.”

Article 11, Additional Protocol, 1988, “Right to a Healthy Environment”

Right to a healthy environment is one of the most important rights for survival of humanity. Its protection must be central to scientific research and development. Harm to other living beings and the environment must be minimised and scientific researchers must conduct research that is sustainable. This right also mandates equitable and appropriate access to biological and genetic resources. Community knowledges, indigenous knowledges about the environment must be considered equally accurate to conventional western sources of environmental knowledge. Ancient wisdom and oral traditions, folk stories and other informal sources of knowledges must be included in the body of scientific research on tackling global challenges.

Promoting access

In the RSSR, the following passages discuss the access of research results by various stakeholders. Point 16.a. (v) suggests that “ to promote access to research results and engage in the sharing of scientific data between researchers, and to policy-makers, and to the public wherever possible, while being mindful of existing rights”

The below-mentioned human rights are relevant in this context of making scientific research and development results accessible.

Article 2, UDOBHR 2005,

“(f) to promote equitable access to medical, scientific and technological developments as well as the greatest possible flow and the rapid sharing of knowledge concerning those developments and the sharing of benefits, with particular attention to the needs of developing countries”

Article 15 , UDOBHR 2005,

“1. Benefits resulting from any scientific research and its applications should be shared with society as a whole and within the international community, in particular with developing countries.”

Right to public access rests on the basic right to access public knowledge, service, and infrastructure available for collective benefit. (This is linked to the right to share benefits mentioned in the preceding sub- section.)

2.2. Linking the human rights to the SDGs

In this section, some of the human rights and human rights-related aspects of the RSSR described in Part 1 are mapped onto the SDGs. The key aim of the mapping process is to tease out and discuss the different ways in which identified human rights can be applied and linked to the SDGs. This requires an engagement with the contents and objectives of the SDGs, and a discussion of the role and significance of the selected human rights to the SDGs at a more general level (or groups of SDGs), and with regard to individual SDGs or SDG targets.

In order to structure the analyse, we focus on three central themes that arise from the RSSR and the human rights introduced in Part 1 above, and which are of major relevance to the realization of science-based approaches for the SDGs. These are:

- human rights that ensure access to research benefits and prevention from any form of exploitation;
- human rights that ensure freedom of expression and participation in decisions surrounding innovation processes and their possible impacts;
- human rights that prevent misuse or other problematic applications and effects of science and technology research, in ways that can harm individuals, human societies or the environment;

Each section will start with a brief description of the overarching theme, and an overview of related human rights. We will then discuss certain human rights (and in some cases inter-related groups of human rights) per section, and examine why and in which ways each of these human rights matter or are relevant to the SDGs. The discussion of each of the selected human rights will follow a three-step structure, which includes (i) a brief discussion of the human right and its relation to the RSSR and section theme; (ii) a discussion of the possible role and significance of this human right to the SDGs at a more general level (e.g., why this human right matters to the SDGs at a more general level / across all or several SDGs), and (iii) an exploration of the possible role, value and contribution of the selected human right to two or three specific SDGs (or SDG targets). We will choose these SDGs as examples, to pursue a more detailed discussion of the human right's relevance. This structure, will help to illustrate the broader significance of selected human rights to the SDGs at a more general level, and simultaneously allow to discuss the possible value and contribution to specific SDGs or SDG targets.

2.2.1. Human rights that ensure access to research benefits and prevention from any form of exploitation

Inclusive research and development and broad access to the benefits and applications of science and innovation processes, are central themes in the RSSR. This includes a commitment to prevent any form of exploitation, of research subjects, vulnerable groups, or communities. (A research subject referred to in this document refers to a participant in a research study; where the study can go beyond medical research) There are three broad themes which are pertinent here. The first theme relates to sharing the benefits of scientific knowledge by treating science as a public good. It must be accessible to the community at large regardless of people's socio-economic context, caste, creed, race, gender or ethnicity. They must not only be passive recipients of scientific knowledge but must be able to contribute to production and dissemination of science as active stakeholders. The second overarching theme relates to confidentiality of data, right to privacy and the right to informed consent. The third set of rights relate to the protection against exploitation and protection of social

and cultural rights. The following paragraphs will discuss the role and significance of the just-mentioned human rights to the SDGs.

2.2.1.1. Sharing of innovation benefits with society as a whole, in particular developing countries

There are several human rights that relate to the sharing of science and innovation benefits with society, the most important of which are- Article 2 (f) UDOBHR 2005 (equitable access to medical, scientific and technological developments and greatest possible flow of knowledge); Article 15 UDOBHR 2005 (sharing of benefits); Article 12 (a) UDOHGHR 1997 (Benefits from advances in biology, genetics and medicine, concerning the human genome, shall be made available to all). These human rights demand that benefits from scientific research and its applications should be shared with society as a whole (Article 15, UDOBHR 2005). Further, professionalism and integrity should be promoted in decision making, especially with the aim to share the knowledge produced (Article 18, UDOBHR 2005).

The realization of equitable and sustainable economic and social development that contributes to indigenous capacity building in developing countries is a central objective of Agenda 2030. However, science and technology-based strategies to achieve the SDGs take place in a context of global inequalities and asymmetric access to resources and scientific capacities. These inequalities can be a feeding ground of potential forms of exploitation, including in research strategies that seeks to realise SDGs. For example, in many cases research and development agendas are disproportionally driven by stakeholders in high income countries. Promising forms of science and technology research that offer the potential for sustainable development or other solutions to global problems are not merely designed to "do good", but they also offer (sometimes very powerful) financial and political incentives, which creates conflicts of interests. In some cases, as the history of international development has shown (Sachs and Santarius 2007), financial interests outweigh a concern with the realization of social and ecological benefits, which has resulted in unequal forms of benefit sharing, exploitative and ethically fraught research collaborations, including the non-reciprocal exploitation of indigenous knowledge and resources, or the disregard of local needs, perceptions and values. Research and innovation that aims to contribute to the SDGs is by no means free from these or similar challenges. For example, SDG 2 (Zero Hunger), SDG3 (Good Health and Wellbeing), SDG6 (Clean Water and Sanitation), SDG7 (Affordable and Clean Energy), SDG8 (Decent Work and Economic Growth), SDG9 (Industry, Innovation and Infrastructure), SDG11 (Sustainable Cities and Communities), SDG12 (Responsible Consumption and Production), SDG13 (Climate Action), SDG14 (Life Below Water) and SDG15 (Life on Land) - all rely at least partly on science and technology-based approaches (in addition to institutional, behavioural, etc. strategies). In the context of international research and development collaborations, including in private sector partnerships, the above-mentioned problems can easily surface.

This is why human rights that promote the sharing of "benefits resulting from any scientific research", "equitable access", and the fair "sharing of benefits", especially in a context of global inequalities, is of uttermost importance. These human rights form important legal instruments that can ensure that a concern with broad access, social and global justice, and appropriate forms of benefit sharing are part and parcel of the research process, and that violations of these rights can result in legal prosecution or reputational damage of researchers or companies who disregard these principles.

We will now discuss the relevance of aforesaid human rights with regard to two specific SDGs. The first is SDG2 (Zero Hunger), the second is SDG3 (Good Health and Wellbeing). Technological solutions to agriculture, such as genetically modified crops or life stock, that promise more efficient and less

resource-intensive food production can form important tools to increase global food production and reduce hunger. However, as the introduction of GMO seeds by companies such as Monsanto has shown, these changes can create substantial disadvantages for local farmers. Reports on the social impact of Monsanto's genetically modified seed products, have put smaller famers out of business, destroyed livelihoods and as a result disrupted local communities (Reboratti 2010; Singh 2009). Above-stated human rights can play a role in preventing such problems, and form a legal tool in lawsuits against companies whose products results in new forms of exclusion and unequal access to innovation benefits.

2.2.1.2 Confidentiality, privacy and consent

This section encompasses the aspect of confidentiality, privacy and consent with respect to science and innovation. In this regard, the human rights that assume importance are- Article 12 UDOHR 1848 (No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence); Article 7 UDOHGHR 1997 (Genetic data stored or processed for the purposes of research or any other purpose must be held confidential); Declaration 8, WMA Declaration 2013 (The rights of individual research subjects); Declaration 9, WMA Declaration 2013 (Protection of confidential data).

The human rights specifically regarding consent delineated within various international legal instruments include Article 7, ICCPR 1976 (right to free consent to participate in medical or scientific experiment); Article 6, UDOBHR 2005 (medical intervention only after free and informed consent; Article 7 UDOBHR 2005 (protecting people incapable of giving consent); Article 5 of the Convention 1996 (medical intervention requires free and fair consent); Article 15 of the Convention 1996 (Scientific research in the field of biology and medicine shall be carried out freely); Article 16 of the Convention, 1996 (protection of persons undergoing research).

A related human right is the right to privacy which is defined coherently in Article 17, ICCPR 1976 which prohibits any arbitrary or unlawful interference with a person's "privacy, family, home, or correspondence", or "unlawful attacks on his honour". This right prevents scientists or anyone engaged with scientific research and development to intrude on a person's privacy for scientific gains. Confidentiality and privacy are based on the fundamental principle of consent, i.e. the choice to decide whether one wants to share certain information integral to them or not. This component of choice is where policy makers, researchers, scientists and other individuals engaged with scientific development have to conduct the balancing act to weigh the cost of sharing information for public good with the possibility of breaching someone's or a community's right to keep that data confidential.

The ethical implications that come into play flow from the impact that sharing of personal information/data can have on an individual or a community in terms of psychological, physical, socio-cultural, economic or political harm. Manipulation of scientific data can also cause exclusion of certain individuals or groups of individuals from accessing certain scientific data, or accessing only certain 'versions' of the data. This raises concerns about accuracy of scientific research results which are made accessible to the public. Where research participants are concerned, it is imperative to understand consent not just in terms of 'individual' consent but also in terms of 'community' consent. RSSR aptly speaks of consultation with 'communities' while conducting research on them or with them so as to ensure minimum harm is caused towards those communities. Consent therefore has a 'collective' role to play at the larger community level in the realm of science and innovation.

Confidentiality, privacy and consent must be protected in order to reach every SDG, especially those which inform collection of data about humans and communities including but not restricted to medical research and biological research (SDG 3 and SDG 11 – see below), but also to policy research that tests efficacy of specific development strategies. For instance scientific strategies such as assessing nutrition patterns to address SDG 1 (end poverty), SDG 2 (end hunger) require informed consent of individuals as well as communities of the effects of the research interventions. Here the "collective" aspect of community consultation and consent is equally important to individual consent. This involves the idea about giving adequate information about a particular scientific research or intervention to the community with which the intervention directly engages. The community must be comfortable with such interventions, must have knowledge of the after-effects of the intervention and must not be coerced to participate in it.

All 3 rights are inter-related, and hinged on the principle of choice of every individual, be it a research participant or a researcher, or a community, to agree to share personal information for carrying out scientific research. Arbitrary interference with the privacy of individuals or groups can be state sponsored or individually carried out. If people's private and confidential information is not protected it would be impossible to achieve any of the SDGs in the true sense. This is because all SDGs are based on one essential element, i.e. learning through knowledge. If the results from scientific research and innovations are based on stolen/misappropriated information of individuals or groups, this information cannot be ascertained as accurate because it is likely to be used for private or State's interests and consequently subject to manipulation. Therefore the knowledge and learning produced from such processes cannot be trustworthy and may perpetuate stigma and discrimination towards vulnerable sections of the population.

Scientific research often involves very intimate, personal details of research participants such as the name, age, sex, date of birth, address, bank account details, medical records, religious and political views and biometrics. When such information which was collected solely for scientific research is misused or leaked, it could cause harm to those individuals in so many ways. For instance, face recognition systems along with machine learning technologies are being misused increasingly by governments to increase surveillance on target and curtail freedoms of minority and marginalised groups, which is a breach of SDG 10 (reducing inequalities). In the case of S and Marper v. the United Kingdom [2008], the European Court of Human Rights held that holding fingerprints, cellular samples and DNA profiles of arrested individuals who were later acquitted or discharged, is a violation of their right to privacy under the European Convention on Human Rights. The Court expressed concern about the risk of stigmatisation and violation of the presumption of innocence of people, which is the foundation of a fair and just trial and forms the foundation of an equitable criminal justice system.

Strategies which aim to achieve SDG 3 (ensure healthy lives and well being) include medical research as also all forms of biological research. These strategies include improving maternal health care, removing barriers for girls and LGBTQAI+ communities to access to education, linking health services directly to users through digital portals and so on. Such strategies have to be implemented, once the individuals and groups have fully consented to be engaged with such endeavours. The data collected during these processes must be kept strictly confidential and must not be misused for any other purposes. Similarly, scientific strategies for achieving SDG 11 (making cities and human settlements inclusive, safe and sustainable) can often create scope for misusing the information collected or implementing strategies without complete knowledge of the community members. Interventions related to "conservation" of natural habitats and resources have to be dealt with after taking informed consent and keeping in mind the impact the scientific strategies would have on their lives

and livelihoods. Similarly, scientific studies on challenges faced by slum dwellers must not be conducted without observing strict rules about consent, confidentiality and privacy to ensure the participants do not face any backlash from within and outside the community.

2.2.1.3 Gender, cultural and community rights

This section addresses the third theme, the protection of social and cultural rights and the right against exploitation. Here the following rights are important- Article 22, UDOHR 1848 (Right to social and cultural rights); Article 14, Additional Protocol, 1988 (Right to the benefits of culture) and Article 10(3), ICESCR 1976 (Protection of children and youth from economic and social exploitation). Every individual has the right to enjoy the cultural and artistic life of their community and the benefits of scientific progress. Further, individuals or groups who have contributed to the scientific research must enjoy the moral and material interests deriving from the scientific development. The lack of protection of such rights can lead to exploitation of vulnerable individuals and groups.

In achieving SDG 5 (ensuring gender equality), prevention of exploitation of excluded gender groups is pertinent. Science and innovation must ensure that the impact of their research results don't exploit or negatively impact gender equations. Taking a look at women as primary water collectors and users in Kenya, scientific strategies that somehow compromise this flow of water from streams in their implementation can negatively impact these women's livelihoods and well- being, cause their further exclusion and severely impact gender relations in their communities. Similarly scientific research and development strategies which aim to achieve SDG 7 (affordable sustainable energy) through sustainable mechanisms of collecting fuelwood, diverting changing livelihood patterns of biogas consumption must be mindful of not interfering with dynamic gender relations, seeing that often women and LGBTQAI+ communities are primary producers and decision makers within these structures. Therefore such interference must not cause further exclusions and precariousness within their lives.

Scientific strategies, in their aim to achieve SDGs must protect the community's social and cultural rights. Scientific studies that interact with tribal populations on issues of protecting the environment have often misused the information gathered against the very same groups to displace them from their own lands, accusing them of 'exploiting' natural resources. Tribal, local and indigenous populations often face interference with their social and cultural rights and extreme social deprivation at the hands of the State. Excluded indigenous communities are repeatedly exploited by scientists, researchers and others who steal their knowledges, traditions and customs regarding scientific processes without their informed consent. This often leads to miscommunication and misinformation about their society and leads to inaccurate scientific results. This is also a barrier for achievement of SDG 16 (Peaceful and inclusive societies and access to justice.

2.2.2. Human rights that ensure freedom of expression and participation in decisions surrounding innovation processes and their possible impacts

Freedom of expression and participation in decisions surrounding innovation processes are central aspects to make science responsible. There are three themes under freedom of expression which are relevant in the context of science and innovation- freedom of thought, freedom to practice religious and cultural rights and participation. Each of these themes are discussed in detail in the following sections.

2.2.2.1. Freedom of speech, expression and opinion

This section refers to the right to freedom of expression and opinions with regard to scientific development and innovations. Here the most relevant rights are - Article 1, UDOHR 1848 (Right to be free and equal in dignity); Article 18, UDOHR 1848 (Right to freedom of thought, conscience and religion), Article 19, UDOHR 1848 (Right to freedom of opinion and expression), Article 2, The Convention 1997, (Primacy of the human being), Article 10, UDOHGHR 1997, (No research or research applications concerning the human genome should prevail over fundamental freedoms and human dignity of individuals); Article 18, UDOBHR 2005, (Opportunities for informed pluralistic public debate, seeking the expression of all relevant opinions, should be promoted); Article 19, ICCPR 1976, (Right to freedom of expression).

Freedom of thought and expression in science and innovation was curtailed at the global level across countries and governments during Covid-19. For instance, the Chinese government imprisoned Zhang Khan, a journalist who went to Wuhan and reported about Corona Virus outbreak. According to a Human Rights Watch report, since January 2020, governments in at least 24 countries enacted ambiguous laws and took stringent measures that criminalize spreading alleged misinformation of Covid-19, or of other public health crises, which the authorities claim threaten the public's well-being. The first issue that arises given this background is the need for accountable mechanisms for ensuring scientists have the freedom to express their opinions as well as criticisms on scientific policies, innovations and research. As mentioned in the RSSR as well, scientists must have the freedom to express themselves openly on ethical, scientific social or ecological values of certain projects and where such projects undermine human welfare and dignity, they can withdraw from the project.

Limitations on freedom of opinion within the realm of science and innovation can take many forms. Restrictions on funding is one way of curbing speech. Scientists and practitioners who need research funding for conducting studies are often left without recourse due to shortage of funds. Similarly, peer-review committees are often used by State or powerful private bodies with vested interests to decide whether certain research proposals deserve funding. Denial of funding on publications pose a significant threat to free speech and expression and stifles innovation. Extending this freedom to community at large is equally important in holding scientific institutions answerable for their actions. Science must be up for public debate and questioning by community stakeholders and practitioners along with mainstream scientists.

As noted in the preceding sections, most of the SDGs involve science and technological interventions to achieve the goals. In each and every scientific development, freedom of thought and expression holds a central place as multiplicity of opinions allows different aspects of the scientific strategies to be debated, rather than a single version of those strategies or research studies. In this regard, SDG 16 is specifically related to the freedom of thought and expression. It aims to "promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels". Freedom of thought and expression helps achieve specific targets of reducing corruption and bribery (16.5), develop accountable and transparent institutions (16.6) and ensure public access to information and fundamental freedoms (16.10). For instance, in an attempt to study long- term health impacts on gas leak victims in industrial towns, [to engage with SDG 3 (ensuring healthy lives and well-being)], scientists conducting the study must have the freedom to withdraw from such a study or voice their criticism of the same if it clashes with the basic principles of honesty, integrity, and human dignity with regard to the research methods and findings.

2.2.2.2. Freedom of thought, belief, religion and culture

This section details the second theme under freedom of expression; being the freedom to practice religious and cultural rights. Article 27, ICCPR 1976, states that "In those States in which ethnic, religious or linguistic minorities exist, persons belonging to such minorities shall not be denied the right…to enjoy their own culture, to profess and practise their own religion, or to use their own language." Article 21, UDOHGHR 1997 speaks of "Free expression of various sociocultural, religious and philosophical opinions". This right is related to the afore-said right to free speech, but specifically caters to religious, socio-cultural and philosophical opinions. The socio-cultural, religious milieu of a community is an important determinant for freedom of expression. Science and innovation can often clash with ancient religious beliefs, or cultural traditions of a society. The ability to debate and criticise scientific advancements vis a vis cultural and religious norms of a society without any physical, psychological, economic or political harm to the community forms the bedrock of inclusiveness and transparency in science.

Freedom of belief, religion and culture is important because many scientific strategies that aim to achieve SDGs involve far reaching social transformation. This can threaten people's religious practices, which define their identity. Scientific developments also have the potential to impact the cultural integrity of individuals and communities through imposition of "modern" ideas and practices. Scientific progress needs to be responsive to its socio-cultural context, interact with ideas, traditions and cultures of the community within which it operates. Scientists must open their minds to inequalities that exist amongst religious and cultural communities, in order to best respond to the gaps in achieving the SDGs. There is a requirement of creating progressive, innovative and inclusive channels of communication to allow co-production of knowledge across different religions and cultures. Scientific strategies that aim to address SDG 11 (make cities and human settlements safe, inclusive and sustainable), SDG 12 (ensure sustainable consumption and production patters) as well as SDG 13 (combat climate change) may want to study forest management; in doing so they could potentially impose a "secular" idea of forest management and consumption pattern which clashes with the concerned community's religious beliefs or cultural sensitivity about the purpose and use of the forest and its resources. Taking another example of sustainable architecture, urban designing can incorporate local practices of orienting buildings or using local building material to keep urban development in harmony with its socio-cultural context, while simultaneously creating sustainable human settlements.

2.2.2.3 Participation

This section pertains to equitable participation of all stakeholders engaged scientific research and development. Article 27, UDOHR 1848 grants the freedom to everyone to freely participate in the cultural life of their community and to share in scientific advancement and its benefits. Article 20, UDOHR 1848 grants the right to peaceful assembly. The other human rights relevant here are- Declaration 13, WMA Declaration, 2013, (Underrepresented groups to have access to equal participation in research); Declaration 14, WMA Declaration, 2013 (participation in medical research only to the extent that it does not harm health of patients); Article 21 (4), UDOBHR 2005 (Equal participation during negotiation of research agreement); Article 23 (1) and (2) UDOBHR 2005 (Bioethics education, training and information); Commentary, International Ethical Guidelines, 2016 (Fair distribution of research benefits). Participation entails that community workers, health practitioners and the general public must be able to understand and question scientific and health developments without fear of persecution. The right to peaceful protest also forms an important part of the idea of participation.

Awareness of above- mentioned HR is important in context of SDGs. Right to participation in scientific research refers to the idea of democratising science, making it accessible and available to

the public at large through their active contributions. Participation in scientific research and development must be encouraged at different levels of production and dissemination of knowledge and in relation to the education, training as well as during the research process itself. When negotiating research agreements including aspects of sharing benefits of research, all parties should have an equal say in the negotiation process. In order to foster a better understanding of ethical implications of scientific research and technological developments, bioethics education must be conducted at all levels of governance, especially targeting youth populations. Indigenous communities and various vulnerable local communities must have an equal say during their contributions towards scientific research and their contributions must be given due credit, both morally and materially. Additionally, community members must be involved with the decision-making about science based strategies to realise SDGs.

Research must not be unduly focussed on the health needs of a limited class of people, but instead aims to address diverse health needs across different groups. History has shown that marginalised groups such as pregnant women and children have often been excluded from participation in research because it was considered the most convenient way of protecting those groups. (Commentary, International Ethical Guidelines, 2016) Consequently, information about the diagnosis, treatment and prevention of diseases faced by them is limited, which has resulted in serious injustice. (Commentary, International Ethical Guidelines, 2016) With respect to increasing participation of women in scientific research and development, certain challenges women face include prejudice against women and other genders which creeps in giving credit for authoring papers or conducting scientific research as well as in scientific education and training. Marginalised genders often receive less funding for scientific research and innovation. Many studies have also shown that women researchers are more likely to hold teaching-intensive faculty positions over research- intensive ones. Studies have shown that sexual violence against women scientists and researchers at their workplace is a lot more compared to their male counterparts. At the community end, less women and people from LGBTQ communities contribute to scientific developments and have less access to scientific results compared with men.

Equitable participation in scientific research and development is the building block for achieving SDGs. Not only is this important because SDGs are created for all, but more importantly it is those excluded and those who face the wrath of global challenges to the highest degree that are most equipped to find practical, community-based sustainable solutions for addressing those challenges. In this regard, SDG 13 (Combat Climate Change), SDG 11 (Make human settlements inclusive and sustainable), SDG 6 (Sustainable management of water and sanitation, SDG 16 (Promote peaceful and inclusive societies and provide access to justice for all) and SDG 5 (Gender equality) assume particular relevance. Climate change, sustainable living and sanitation are inter-related in the sense that addressing one of these challenges directly impacts the other. Participation of local communities, indigenous communities in actively finding solutions to these global problems is very important, since they have survived while dealing with these challenges in their everyday lives. They have knowledge of their environment both naturally and locally; they can use development strategies through local knowledge and established practices which are woven in the social fabric of their communities, thereby making intervention effective.

Scientific development and innovation projects need to adapt to local conditions shaped by different socio-cultural and economic realities of people. Participation can empower local communities to develop sustainable solutions to SDG 13, SDG 11 and SDG 6 specifically, by using their local knowledges and resources. Participation can foster resilient action-driven scientific research. It can also help make science more responsive to community needs by allowing stakeholders at different

levels to engage with it. Participation can help achieve SDG 16 by making science accessible; as more people from diverse backgrounds and cultures participate in co-producing scientific knowledge in different languages, more people will be able to access and understand them. This will make science more inclusive and responsive to societal needs. In order to achieve gender equality as laid out in SDG 5, tokenism in representation and contribution of marginalised genders has to give way to substantial and wholesome contributions and expression by them towards science and innovation.

2.2.3. Human rights that prevent misuse or other problematic applications and effects of science and technology research, in ways that can harm individuals or human societies

This section aims to discuss the human rights which specifically prevent misuse of scientific results and how they need to be protected to realise SDGs.

2.2.3.1 Misuse / Dual use

This section discusses human rights and their relevance for achieving SDGs where science and technology research may be misused or may have a dual use and which may harm individuals and societies. In this context the relevant human rights are: Article 3 ICCPR 1976 (effective remedy for violations of rights and freedoms); Article 8 UDOHGHR 1997 (right to reparation for damage as a result of intervention affecting his or her genome); Article 3 UDOBHR 2005 (Human dignity and human rights to be fully respected; interests of individuals should have priority over sole interest of science or society).

Misuse or dual use of scientific research, interventions have particular relevance in the context of scientific strategies which aim to achieve SDGs. Any intervention can only be successful, both morally and practically for the benefit of that community if it is used solely for the purpose for which it was initiated. Any form of misuse could subvert the beneficial aspects of that intervention. In particular SDG 1 (ending poverty); SDG 2(ending hunger); SDG 7 (access to affordable, sustainable energy); Goal 12 (sustainable consumption and production patterns) require that scientific solutions developed for addressing the goals have strict monitoring and implementation mechanisms. They must be designed within a strict accountability framework to avoid misuse of scientific strategies which may cause more harm than good for the community at hand. Very often scientific technologies used for scaling up agricultural reforms, or consumption patterns misuse the scientific tools to further state's political agendas or private interests.

Specifically looking at SDG 2 (end hunger, food security and promote sustainable agriculture), scientific research and interventions that support urban agriculture are susceptible to misuse by parties which may want to use the opportunity for profit-based gains. For this purpose, in the name of "educational food courses" and building local supplies shops in agricultural villages, scientific strategies must not be misused by large corporates for promoting their own fertiliser or urban agricultural-tools brands. Similarly scientific solutions for sharing water resources over geographical boundaries (achieving SDG 6 which refers to availability of water) must not be misused for diverting funds (to be used for such projects) for monetary or political gains of third parties.

3. Recommendations

Niharika Kaul

Regional, State and National Governments

- Member States should devise machinery for formulation and execution of policies that commit to human rights that are mentioned in this document in order to ensure that research processes and research outcomes are translated and applied for societal good
- Member states should urge scientific researchers to take into account human rights such as access to scientific research; consent from individuals and community members; and freedom of expression within the realm of science and technology
- Member states should invest in public health infrastructure and scientific research for public needs. 'Science hubs', 'science shops' and similar tools can be used to build a 'culture of science' which includes knowledges of community members and is responsive to their needs

Funding bodies

- Funding bodies should fund research publications, keeping community needs before their own private interests.
- Research produced in the global south, informal knowledges, ancient traditions and customs should be viewed by funders as legitimate sources of scientific knowledge

Research Governing Bodies (these include regulatory bodies)

- Research governing bodies should establish strict monitoring and evaluation mechanisms based on principles of integrity, honesty and collective action to hold researchers and research institutions accountable for their research methods and results
- Employment contracts for researchers and practitioners must be non-discriminatory, inclusive and equitable, including terms of employment and working conditions.
- All parties to a research agreement have equal say in the terms and conditions of the agreement

Researchers performing organisations (These include but not limited to research institutes, schools, universities, companies/corporates, civil society organisations)

- Research performing organisations are encouraged to find suitable means to address human rights dimensions in scientific research. Independent ethics committees must address human rights mentioned in this document while dealing with scientific research projects
- Create equitable research partnerships between researchers, practitioners and other community members who participate in the research directly or indirectly.
- Researchers who are party to a research project, must have full freedom to express their views and opinions on the subject they are researching on, and have full freedom to withdraw from research projects where it clashes with their ethical principles, fundamental freedoms and conscience.

Societal organisations shaping and influencing research (These include but are not limited to civil society organisations, activists, think tanks)

- Liaise with governments, research governing bodies and research performing organisations to improve access to scientific research by community members
- Conduct capacity building, training of different stakeholders to bridge the gap between science and community, including education and training of scientific researchers to encourage the "spirit of service" and building inclusive, sustainable and ethical scientific research practices

Part II: Discussion

Chapter 7: RRI and SDGs

Hub Zwart

1. Introduction

The overall aim of the RRING project is to bring RRI into the linked up global world via mutual learning, sharing best practices and collaboration. One of the key objectives of RRING is to align RRI with the Sustainable Development Goals (SDGs) as a global common denominator for addressing global societal challenges. The 17 SDGs represent a universal call to action and a framework for tackling global challenges, including health and well-being, climate change, and poverty, while achieving a better and more sustainable future for all.

Responsible Research and Innovation (RRI) implies that research performing organisations and societal actors (citizens, policy makers, companies, non-governmental organisations, etc.) work together during the entire research process in order to better align its outcomes with the values, needs, concerns and expectations of society. The aim is to make research more inclusive by involving more voices, experiences and perspectives from society. By making RRI an inherent component of innovative research, RRI projects aim to foster public engagement and to enable access and uptake to scientific results.

Two dimensions of RRI must be distinguished. RRI wants research to be conducted *for* society as well as *with* society. Research and innovation must be undertaken to achieve socially desirable and acceptable ends (for society), by making it more participatory and inclusive (with society). Although both dimensions should be distinguished, they evidently belong together, and the one cannot be separated for the other. It is by including the knowledge, perspectives and experiences of societal stakeholders that societal challenges can be met. Thus, in order to monitor and assess how RRI evolves, we need both process indicators (assessing the extent to which research and innovation are becoming an interactive, inclusive and participatory process) as well as product or impact indicators (assessing the extent to which research and innovation contribute to addressing societal goals). Increasingly, the Sustainable Development Goals are used as a scaffold for assessing societal impact (i.e. the extent to which research and innovation work for the benefit of society and foster society's capacity to address societal challenges). In other words, the SDGs allow research performing organisation, notably universities, to measure, determine and enhance their societal impact. Here again, however, goals and results (the "product" dimension of RRI) remains intimately connected with the "process" dimension (inclusiveness, participation, etc.).

The RRING proposal submitted to the European Commission already announced to produce two policy briefs. Whereas policy brief 1 focussed on developing indicators for the UNESCO recommendation on science and scientific researchers, the focus of policy brief 2 is on the contribution of RRI as an evolving concept to advancing sustainable development goals via mutual global learning. As was argued in RRING Deliverable 4.1, we currently notice that RRI is evolving in two directions. First of all, we notice a *pragmatic turn* towards tool development and institutional embedding, supported by European (H2020) projects such as RRI Tools,[26] MORRI[27] and RRI

[26] https://rri-tools.eu
[27] http://morri-project.eu

Practice.[28] Building on the RRI Tools projects, for instance, Klaassen et al (2019) argue that conceptual work on RRI is itself an innovative process and that a further conceptualisation of RRI will benefit from actually *practicing* RRI ("laying the path while walking it"). Researchers and their organisations should from experience, gradually adjusting their assumptions while trying out new behaviour. Thus, RRI is seen as a "collective experiment" (Klaassen et al 2019, p. 90), a collective *learning process*, supported by mutual learning methodologies. Secondly, we notice a *global turn*, exemplified by efforts to present RRI in a global context, connecting and comparing RRI with similar processes in other global regions. Here again, RRI is seen as a global mutual learning process, allowing us to compare and share evolving best practices across global regions.

The core aim of this policy brief is to outline how RRI can contribute to realising SDGs, building on the conviction that, in order to make science more sensitive to societal needs, expectations and concerns, we need a science that is different from what we have today have: a science that crosses boundaries (between disciplines, between science and society, between laboratories and life-worlds, between global regions).In order to address the global societal challenges we are facing today, science must become more comprehensive and inclusive. What we aim to achieve is practical advice and strategies that enhance societal trust and support for science, by outlining how the linking of RRI and SDGs may work for the benefit of all.

[28] https://www.rri-practice.eu

2. Sustainable Development Goals

The Sustainable Development Goals (SDGs) or Global Goals consist of seventeen interlinked global societal goals designed to achieve a better and more sustainable future for all.[29] The SDGs were defined in 2015 by the United Nations General Assembly and are intended to be achieved by the year 2030. Each goal typically has 8 to 12 targets, and each target entails a set of indicators that can be used to measure progress toward reaching those targets. These targets are either "outcome" targets (goals to be attained) or "means of implementation".

[29] https://www.un.org/sustainabledevelopment/sustainable-development-goals/

3. Contribution of RRI to realising SDGs

The following overview presents a first explorative outline of how RRI could foster SDGs:

SDG		RRI contribution
4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	The goal of RRI is to make research and innovation more inclusive. This means involving societal actors in long-term mutual learning endeavours, where both RPOs and the societal environment are considered as learning environment or systems. Via active outreach, citizens and NGOs become involved in research as a learning process. Moreover, via innovative education, future academics are empowered to flourish in interactive and inclusive research.
5	Achieve gender equality and empowerment of women and girls	Gender is one of the Keys of RRI as an approach to foster inclusiveness also in terms of gender.
8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	RRI not only aims to contribute to sustainable growth via responsible innovation, but also has an internal dimension: quality and security of working conditions within research performing organisations to develop societal engagement and interaction
9	Promote inclusive innovation	Innovation (e.g. technological, industrial and infrastructural innovation) should not only be acceptable to society, but should include the views, needs and concerns of societal stakeholders for the very outset as an inherent dimension of responsible research and development
10	Reduce inequality within and among countries	Via international collaboration and mutual learning, RRI aims to reduce inequalities between global regions. Whereas research often resulted in “epistemicide” (the systematic elimination of rival local knowledge systems, RRI aims to make research sensitive to cultural context and multiple knowledge forms.
11	Make cities and human settlements inclusive, safe, resilient and sustainable	RRI not only contributes to SDGs on a global level, but also more directly at a lobal level, as RPOs become responsive to their immediate social environment. E.g. UCC and EUR (lead partner) both participate in UNIC, a European alliance of eight universities based in post-industrial cities with a mission to boost mobility and inclusion for societal impact.
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective,	We live in a world of global competition between regions (e.g. the USA versus China), which includes technoscience, e.g. competition in the domain of ICT and other advanced technologies. The aim of RRI is to replace competition with collaboration and mutual learning also on a global level and to make technoscience sensitive to cultural context.

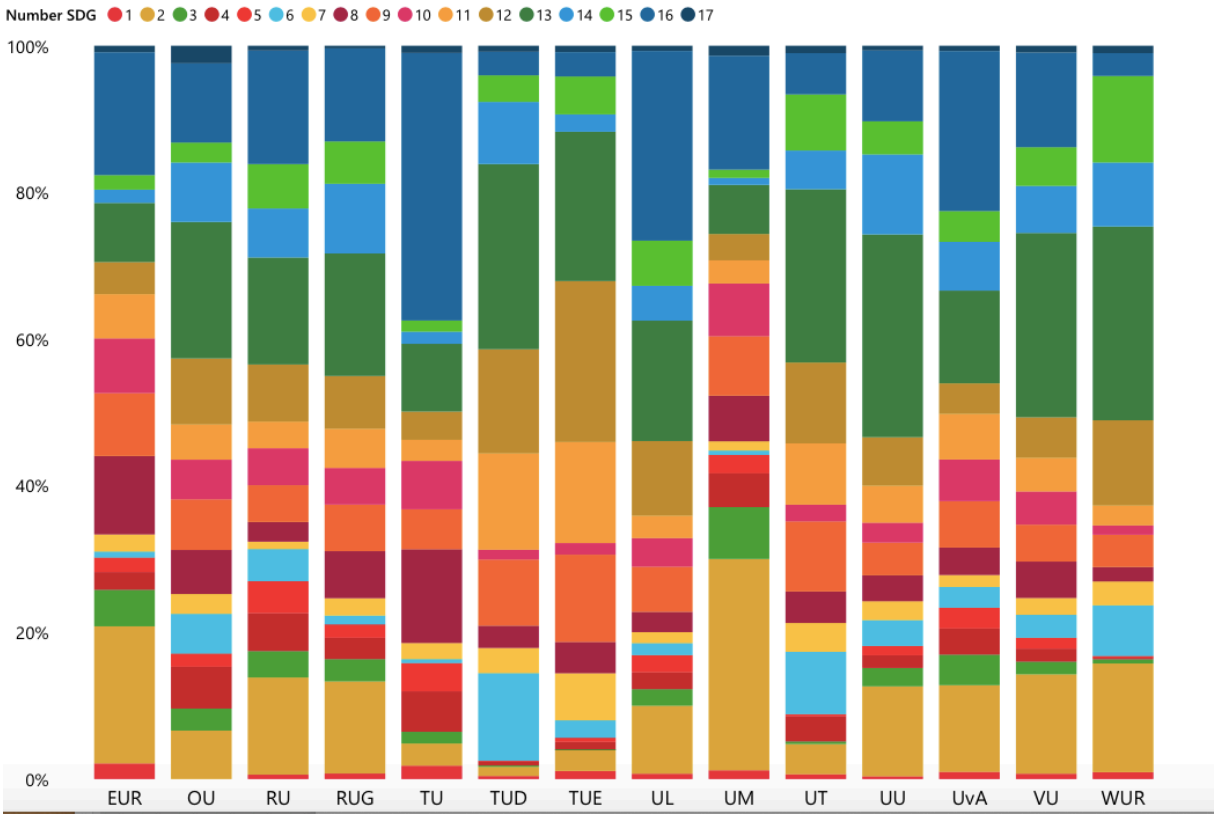
	accountable and inclusive institutions at all levels	

To determine the contribution of RRI to SDGs, quantitative indicators providing comparative metrics are required. This is provided by SDG dashboards.

SDG Dashboards

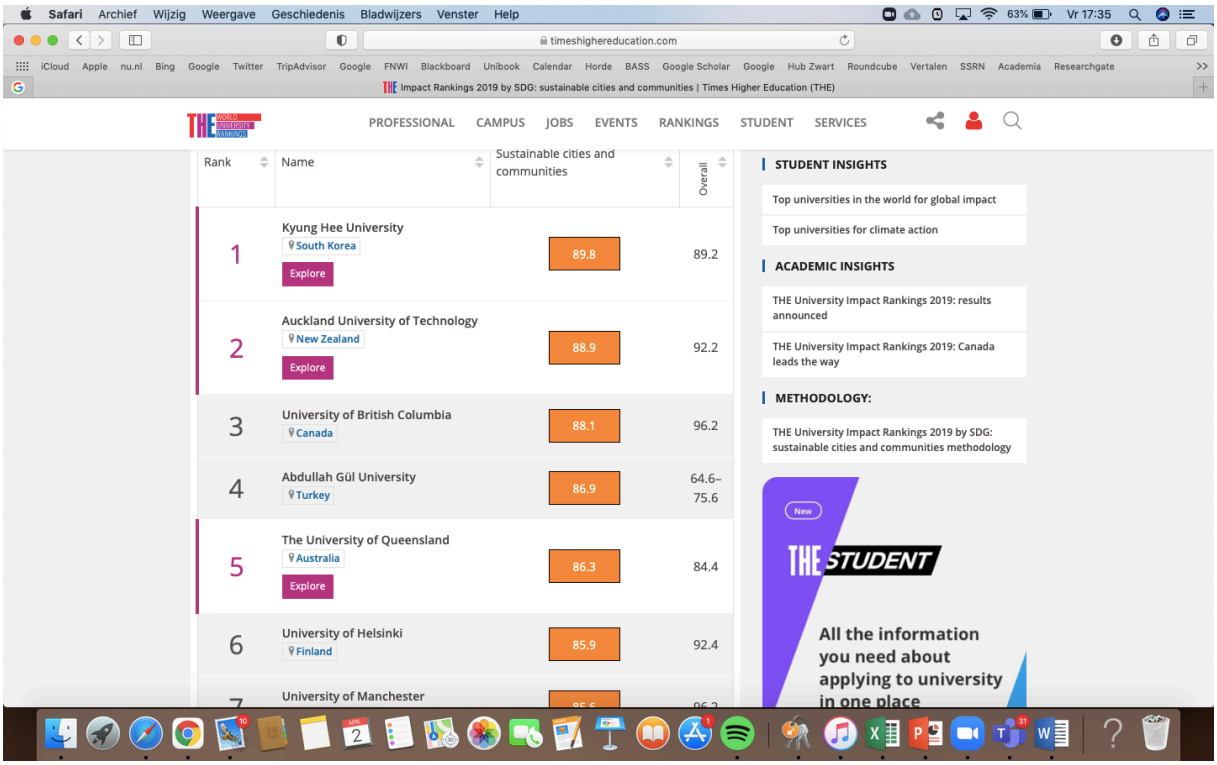
The SDG Interactive Dashboard[30] is a data-driven initiative that supports tracking and monitoring of SDGs. The platform currently uses data from the UN Statistics Division's (UNSD) SDG Global Database, allowing users to explore and visualise progress. The Dashboard enables governments, policy makers, researchers, non-governmental organisations, media and others interested in tracking SDGs to comparatively monitor SDG performance. For instance, they can monitor their country's progress, or explore trends concerning particular SDGs.

In response to this, universities are currently designing their own SDG dashboard to measure and visualise their societal impact in terms of these seventeen goals. An example of this is the SDG dashboard designed by the *Association of Universities in the Netherlands* (VSNU) to determine the contribution of Dutch universities to SDGs.[31] For instance, the visual below shows the relative distribution of SDG related publications per university. For each university it is possible to see which SDGs they publish about.



[30] https://www.sdgsdashboard.org
[31] https://www.vsnu.nl/en_GB/sdg-dashboard-english.html

Such data visualisations are doubtlessly relevant, for various reasons. They make researchers and research organisation more aware their involvement in fostering sustainability goals. In addition, such visualisations may serve as a measure of progress for RPOs who are consciously reorienting their work from traditional quality indicators (e.g. number of publications, citations, research grants, or even the number of CEOs of companies among the alumni, etc.) towards societal impact. The latter is notoriously difficult to measure and for this, de SDGs may provide a framework. As the term dashboard indicates, it allows for a real-time, continuous assessment of performance in terms of relevance and societal benefits. Finally, these dashboards give rise to global impact rankings of universities, as an alternative to more traditional performance rankings:



Yet, these quantitative indicators do not inform us about how inclusion and interaction actually work out in practice. To use a metaphor, a dashboard informs us about speed and fuel use, but not about, say, the quality of the conversations evolving inside the vehicle, or the quality of our music experience. Therefore, we have to zoom in more concretely on how RRI may contribute to the realisation of SDGs in practice.

4. Aligning with the results of RRING WP4

This view is in alignment with the results obtained in RRING Work-Package 4. The aim of RRING Workpackage 4 was to analyse, compare and assess RRI best practices and mutual learning opportunities across five global regions as defined by the United Nations and UNESCO.[32] The results were presented in RRING Deliverable 4.1. In this document it was argued that RRI evidently has a role to play in achieving the sustainable development goals. The SDGs already played a role in the design of the work carried out in WP4. In Chapter 2, for instance, we concluded that SDG relevance can be an important driver for facilitating organizational engagement in RRI-like practices, while organizational engagement in RRI-like practices can have competitive advantages in promoting SDGs (p. 114, p. 384, p. 385). This argument was also endorsed in WP5. The UN SDGs are widely acknowledged as a frame of reference for indicating societal impact and relevance. The SDGs can play an important role in the aligning of innovation processes with societal and environmental needs. Notably in industry, the UN SDGs clearly influence innovation decisions (D4.1, p. 460).

Yet, it was also argued that there is a potential downside to the success of SDGs as a common denominator for impact. Notwithstanding their positive role, they can also be used in strategic ways to emphasise the possible benefits of emerging technologies, and to mobilize public support while pre-empting public criticism. As several studies have shown, in practice these promises are often exaggerated. In many innovation domains, uncertainties exist whether promised benefits can be achieved, or whether a specific technology really offers the best possible solutions to a particular problem (D4.1, p. 456). In addition, the framing of an emerging innovation's potential to address global challenges such as drought and climate change, may also invite innovators to downplay or ignore potential risks and adverse effects, including the risk of unintentional societal and environmental consequences. In other words, although SDGs evidently play an important role as indicators of societal impact, they have to be handled with care and in a responsible manner. D4.1 provided input for this. To address how RRI contributes to SDGs in practice, building on quantitative comparable results as reported in D4.1, we have to dive into concrete settings and conduct value research based on mutual learning, which requires a different methodology, more tailored to participatory research and inclusive innovation.

RRING Deliverable 4.1 presents comprehensive research findings on RRI at the globe. We relied on multiple data sources, including large scale interview study, large scale survey study, and glocal workshops. We took both quantitative and qualitative approaches for the analyses of these data, the research findings of which reported in different sub-reports of this deliverable complemented each other. On this basis, D4.1 as a collaborative document provides a wealth information on how RRI practices were implemented and promoted around the globe. However, we also argued that this comparative overview would benefit from follow-up case studies and value research. One option, we argued, would be to organise a mutual learning workshops involving research performing organisations, research funding organisations and societal stakeholders in specific locations or domains. Based on our results, such workshops would add more detail concerning the concrete opportunities and challenges of RRI to contribute to SDGs. Also, such workshops could indicate where organisation and stakeholders could learn from each other. To elucidate this further, in the net section, as indicated, we will zoom in on one pressing example, namely the inclusion or exclusion of indigenous knowledge.

5. A test case: indigenous knowledge

The focus on indigenous knowledge is obviously a conscious choice. We may see it as a test case to determine whether RRI is only endorsed verbally or actually practiced.

[32] Zwart (ed.; multiple authors) (2021) Report on RRI Best Practices and Learning Opportunities. RRING Deliverable 4.1.

It is estimated that there are 476 million indigenous peoples in the world (although he exact number may vary depending on definition, etc.), living in 90 countries, speaking an overwhelming majority of the world's estimated 7,000 languages, and represent 5,000 different cultures. Often existing in the less visible areas, the folds and margin of the global economy, their cultures and styles of living are under siege and endangered by cultural homogenisation and globalisation. They constitute about 5% of the world population, but account for nearly 15% of the world's poor. At the same time, they have a significant influence and often live in close proximity to the natural resources on which the health of the global ecosystem depends. They manage 28% of the world's land surface and, are the *de facto* guardians of 80% of global biodiversity – including most of the plant and animal species on Earth. As family farmers, fishers, pastoralists and forest-dwellers, indigenous peoples apply traditional methods of land management and food production which have evolved over centuries and which have often proven their sustainability and resilience in the face of environmental and socio-cultural transitions. The vital role of indigenous peoples was recognized in the 2007 UN Declaration on the Rights of Indigenous Peoples (UNDRIP). And yet, indigenous peoples continue to suffer disproportionately high levels of land insecurity, social dislocation and violence while defending their traditional lands.

In this report, we will focus on the epistemological resources of indigenous cultures. Increasingly, the global community is becoming aware, not only of the detrimental impact of certain aspects of globalisation on indigenous culture, but also of the unique value represented by indigenous forms of knowledge, as an intellectual and moral resource for addressing environmental and socio-political crises.

6. Exercise in retrieval

Three stages can be discerned in the history of knowledge (Zwart 2021a). During the first stage, knowledge emerged in the context of concrete collaborative practices while reflecting a comprehensive worldview. Subsequently, the tendency emerged to segregate knowledge from the traditional socio-cultural matrices from which knowledge practices initially emerged. We already notice this in the work of Plato, for instance, when knowledge (ἐπιστήμη) is distinguished from mere opinion (δόξα), but this distinction became radicalised in the early modern period, during the scientific and industrial revolutions, when the West began to deviate from the common human pattern (Romein 1954; Zwart 2021b). As French philosopher of science Gaston Bachelard argued in multiple studies, modern science requires a conversion from its practitioners, a radical change of mind-set, notably brought about by laboratory research and its rigid methodologies (Bachelard 1938; Zwart 2020). Traditional knowledge resources became disqualified as ideology, superstition, mythology, witchcraft, astrology, folk knowledge, etc., in short: as practices which constituted an *epistemological obstacle* to scientific progress and Enlightenment. From the perspective of science and Enlightenment, the realm of traditional and practical knowledge suffered from biases and knowledge deficits.

Currently, we are noticing a reset. First of all, knowledge producers (e.g. researchers and research performing organisations) are experiencing systemic knowledge deficits. Although technoscientific knowledge is remarkably sophisticated and precise, we are increasingly becoming aware of inherent biases and blind spots as well. In addition, we are facing tremendous societal challenges and in order to address them, we realise that we have to radically broaden our epistemological scope and methodological repertoire. Knowledge must become more comprehensive and inclusive. This inevitably entails a rehabilitation of indigenous knowledge. Finally, last but not least, indigenous peoples themselves are becoming more vocal in recognising the value of their knowledge and emphasising their epistemic rights. Therefore, the conviction is spreading, also within RPOs, that we must indigenize and / or decolonize our knowledge production systems.

In psychology, to take just one example, Henrich et al. (2010) have argued that 96% of the research subjects participating in psychological research samples are "Western, educated,

industrialized, rich and democratic", i.e. WEIRD, and very often psychology students. Therefore, experimental psychology only reflects 12% of the world's population. Unfortunately, despite these narrow and non-inclusive samples, behavioural scientists often draw inferences about human behaviour in general. Even worse, there seems to be a considerable lack of interest in assessing how well results from WEIRD samples can be extrapolated to the global population. Yet, it is clear that, in psychology and other social sciences, decolonisation will have significant impact on education, research, governance, nursing and counselling (Hall et al 2017).

Thus, there is a shift of tendency from exclusion towards inclusion, notably concerning indigenous knowledge. This raises the question how this affects RRI and SDGs. RRI began as a euro-centric notion. Innovation is often considered a Western value, closely connected with individualism, entrepreneurship and competition. This may raise question such as: What is wrong with stability, or with more collective and communitarian forms of innovation? These questions inevitably emerge when we aim to foster RRI on a global level via mutual learning. It is against this backdrop that a focus on indigenous epistemic rights becomes an urgent task. And this also applies when it comes to promoting inclusive and responsive innovation to further SDGs.

Many SDGs are directly or indirectly relevant for the interests and concerns of indigenous peoples. And yet, at first glance, their unique position and interests seem to be underrepresented in the way in which these goals are defined. Several critics have argued that the few SDG indicators in which indigenous peoples are explicitly included do not reflect indigenous views and definitions of well-being. We have to deep deeper into the SDG architecture to recognize how indigenous peoples are involved in this. This is evidently an important issue, for if RRI is fostered for the benefit of the global community, the question emerges how indigenous peoples are included and engaged in the process and how the outcomes will benefit rather than endanger their forms of existence.

In 2016, the International Labour Organisation published a concise overview of how indigenous peoples are involved in SDGs:

1 	Poverty	Indigenous peoples are overrepresented among the world's poorest population groups. Poverty among indigenous peoples is a major challenge as they also experience social, economic and climate-related vulnerabilities, and lack adequate access to economic resources.
2 	No hunger	Indigenous peoples experience disproportionately high levels of malnutrition, notably because of environmental threats on their land and natural resources for cultivation, hunting and gathering, fishing and pastoralism.
3 	Good health and well-being	The life expectancy of indigenous peoples is as much as 20 years lower than that of their non-indigenous counterparts. Often lacking adequate access to health-related services and information, indigenous peoples experience disproportionately high levels of diseases such as malaria and tuberculosis, and also of HIV and AIDS. They are also more likely to experience disability. Suicide rates, particularly among indigenous young people, are considerably higher in many countries
4	Quality education	A critical education gap remains between indigenous peoples and dominant populations. Indigenous peoples tend to have poor access to

		quality education and training, while their traditional skills, practices, modes of learning and languages are also often not recognized,
5 	Gender equality	Indigenous women and girls make significant contributions to livelihoods, unpaid care work and food security but ften lack adequate access to quality education, training, social protection and economic resources, while being exposed to exploitation and gender-based violence
6 	Clean water and sanitation	Indigenous peoples suffer disproportionately from inadequate access to safe drinking water and sanitation services. This is one of the key reasons for the prevalence of certain diseases.
7 	Affordable and clean energy	Many indigenous peoples live in remote rural areas, they lack access to affordable and reliable energy, while being the victims of contamination of natural resources, forced displacement and low-paid labour.
8 	Decent work and economic growth	Indigenous peoples face numerous threats to their traditional livelihoods, are forced to cope with difficulties in securing decent work. The impacts of climate change have exacerbated their already insecure livelihoods. Many indigenous women and girls work in the informal economy in a range of activities such as agricultural labour or domestic work, where they are particularly vulnerable to exploitation. While indigenous peoples face a range of challenges in the world of work, their traditional knowledge and practices are crucial for sustainable economic growth that is sensitive to environmental considerations. For instance, sustainable tourism, together with the promotion of local cultures and products.
9 	Industry, innovation and infrastructure	Innovation based on traditional knowledge and the growth among indigenous peoples of small-scale enterprises (green growth).
10 	Reduced inequalities	Indigenous peoples tend to be excluded from social, economic and political processes at the national and subnational levels. This fundamentally stems from a lack of consultation of indigenous peoples and the mechanisms for their participation in decision-making. Such processes include national development strategies and policies that directly affect their ways of life. The do not share equitably in the benefits of the economic growth.
11 	Sustainable cities and communities	Indigenous women and men have increasingly been migrating to urban centres where they find employment in the informal economies. This furthers the exclusion of indigenous peoples in urban settings and increases their social and economic vulnerability.
12	Responsible consumption	Unsustainable consumption and production patterns that do not respect the environment have had severe negative consequences for indigenous peoples. Many indigenous communities have been

	and production	alienated from their traditional lands and territories as a result of both un- sustainable resource extraction and contamination of their environment. At the same time, in many countries, indigenous women and men have been excluded from the management of natural resources. This considerably limits their potential to draw on their traditional knowledge in contributing towards the sustainable management and efficient use of natural resources.
13 	Climate action	For many indigenous peoples, climate change is already a reality that threatens their livelihoods and ways of life. They are among the first to face the direct consequences of climate change as they are heavily dependent on natural resources and the environment. Even though indigenous peoples contribute little to greenhouse gas emissions, in many countries, climate change poses a threat to their very existence. At the same time, climate policies and action that overlook the specific needs of indigenous peoples, risk increasing their existing social and economic vulnerability. Incorporating the traditional knowledge and ways of life of indigenous peoples into climate mitigation and adaptation measures is essential if climate action is to succeed, for instance in the management of natural resources.
14 	Life below water	Many indigenous communities are dependent on the oceans, seas and marine resources for their livelihoods and food security. However, the rapid growth in fisheries has led to overfishing in many areas, while environmental degradation has also contributed to the depletion of certain marine resources. The over-exploitation of marine resources has resulted in threats to the livelihoods of indigenous peoples, who have traditionally been disciplined in harvesting and developing their fisheries. At the same time, indigenous peoples have an important role to play in developing alternative approaches and sustainably managing marine resources.
15 	Life on land	Lands, forests and biodiversity are at the heart of the cultures and ways of life of indigenous peoples. Millions of indigenous women and men worldwide depend on forests for their livelihoods, and on activities such as cultivation, hunting-gathering or pastoralism, increasingly under threat from deforestation, desertification, land degradation and biodiversity loss. Yet, indigenous peoples possess a wealth of traditional knowledge and practices relating to the sustainable management of natural resources.
16 	Peace and justice: strong institutions	Indigenous peoples have historically suffered grave injustices and, in many settings, continue to face violence and serious violations of their human rights. participatory and representative decision-making at all levels by indigenous peoples is contributing to the perpetuation of injustices. At the same time, they foster moral and cultural resources that provide alternative frameworks to ideologies supporting exploitation.
17	Partnerships for the goals	Indigenous peoples and their organizations and networks are fundamental partners for global collaboration. official statistics and data processing often renders indigenous peoples invisible, while

		indigenous peoples organisations can be instrumental in data collection in support of sustainable development.

In 2016, the *Major Group for Indigenous Peoples* published a document entitled *For Indigenous Peoples around the world*.[33] In this document, they explain why the motto "ensuring that No One is left behind" is especially relevant for indigenous peoples, who are often among the world's most vulnerable and disadvantaged. The usual quantifications and metrics fail to highlight this, for instance because they obfuscate nonmonetary measures of well-being. The financial measure of $1.25/day for extreme poverty is questionable for indigenous peoples, for instance, for whom security of rights to lands, territories and resources is essential for poverty eradication. From this perspective, the linear monetary measure of poverty can contribute to further impoverishing them. The group therefore advocates a different stance. Indigenous peoples play a crucial role in resistance against deforestation, land degradation and climate change. In traditional models, this crucial role is often overlooked or even denied, because it doesn't fit into quantification models. What is important is that knowledge derived from indigenous, local and traditional sources, is appropriately credited, acknowledged, and compensated. For although indigenous peoples are among the most vulnerable and marginalized groups, they are also active participants and partners who are making important contributions to sustainable development. Indigenous peoples are often the custodians of many of the planet's most biologically diverse areas, as well as of a wealth of traditional knowledge and practices concerning ecosystem management, but also concerning medicinal plants, local crops and seeds. Indigenous peoples, including indigenous women, have a proven track record of responsible management of natural resources in forests, deserts, tundra, and small islands. Although these realities are increasingly recognized, indigenous peoples seldomly share in the benefits of the commercialization of their knowledge. In short, we direly need indigenous knowledge for sustainability, but their contribution should be explicitly included and rewarded.

[33] https://sustainabledevelopment.un.org/content/documents/10135IPMG.HLPF.pdf

7. RRING Reports on the contribution of indigenous knowledge to SDGs

First of all, RRING had contributed to UNESCO's updated *Recommendation on Science and Scientific Researchers* (RSSR). Concerning indigenous knowledge, the RRR recommends that Member States should ensure that knowledge derived from indigenous sources, is appropriately credited, acknowledged, and compensated. In addition, they should ensure that the resulting knowledge is transferred back to those indigenous sources, while agreements on the benefits and accessibility of the research is established with full participation of the communities concerned.

Subsequently, a series of RRING reports has been delivered which aim to map the RSSR recommendation to the SDGs. One of these reports examines the human rights dimension,[34] reflecting on the ways in which (a) the RSSR's commitment to human rights can be mapped onto and actively applied in the context of science-based strategies to realise specific SDGs, and (b) how a commitment to human rights norms can be strengthened in the context of national and international research and development activities that emerge in relation to the SDGs. In this context, explicit attention was given to the role of indigenous knowledge. It is stated that indigenous communities possess rich knowledge about myriad aspects of life, even though they often do not have this knowledge codified in written texts according to western standards of codification (p. 12). A core concern in this report is that indigenous communities should not only be the passive recipients of scientific developments, but that they should be actively involved in and allowed to contribute to research and innovation efforts to realise SDGs. Indigenous knowledges about the environment must be considered equally valuable compared to Western sources of environmental knowledge (p. 15). Ancient wisdom and oral traditions, folk stories and other informal sources of knowledges must be included in the body of scientific research on tackling global challenges.

In addition, the report calls attention to unequal forms of benefit sharing, and to exploitative and ethically fraught research collaborations, including the non-reciprocal exploitation of indigenous knowledge and resources, as well as the disregard of local needs, perceptions and values (p. 18). Research and innovation that aims to contribute to the SDGs is by no means free from these or similar challenges, the report argues. For example, SDG 2 (Zero Hunger), SDG3 (Good Health and Wellbeing), SDG6 (Clean Water and Sanitation), SDG7 (Affordable and Clean Energy), SDG8 (Decent Work and Economic Growth), SDG9 (Industry, Innovation and Infrastructure), SDG11 (Sustainable Cities and Communities), SDG12 (Responsible Consumption and Production), SDG13 (Climate Action), SDG14 (Life Below Water) and SDG15 (Life on Land) - all rely at least partly on science and technology-based approaches (in addition to institutional, behavioural, etc. strategies). In the context of international research and development collaborations, including in private sector partnerships, the above-mentioned problems can easily surface.

According to this report, indigenous communities are repeatedly exploited by scientists, researchers and others who appropriate their knowledges without their informed consent. communities must have an equal say during their contributions towards scientific research and their contributions must be given due credit (p. 21). Participation of indigenous communities in actively finding solutions to global challenges is crucially important, since they have survived while dealing with these challenges in their everyday lives. Their environmental knowledge is woven into the social fabric of their communities, thereby making intervention effective.

A second report focusses on ***Open Access/Open Data/Open Science (OADS)***.[35] Once again, building on the RSSR, the report argues that science can have benefits for indigenous groups, but that the reverse is also true: that indigenous knowledge can and should be included in addressing

[34] Kaul, N., Rosemann, A. (2021) Mapping the RSSR to the SDGs: Team Report Human Rights Theme

[35] Adams, A., Rosemann, A. (2021) *Mapping the RSSR to the SDGs: Team Report* ***Open Access/Open Data/Open Science (OADS).***

sustainability challenges, provided that the indigenous communities, whose resources may have been a crucial component in the research, are given suitable recognition of their contribution (p. 10). In addition, the report argues that the current system of granting monopolies on seed stocks and other aspects of plant hybridisation, is skewed towards the profits of large multi-national corporations and therefore often detrimental for indigenous populations whose local bio-resources often form the basis of new developments (p. 20). Here, the Nagoya Protocol on fair and equitable use of resources – a supplementary agreement to the *Convention on Biological Diversity* (CBD) –, which aims to promote fair and equitable sharing of benefits derived from the use of genetic and other biological resources, constitutes an important starting point here. The authors emphasise the importance of indigenous capacity building and inclusion of researchers from the global South in the active development to SDG related solutions, while brain drain must be prevented. In short, while indigenous communities must be included in the development of comprehensive solutions to sustainability challenges, as custodians of local bio-resources, as well as of the knowledge practices involved in ecosystem stewardship, provided this contribution is duly acknowledged and benefits are equitably shared.

A third report focusses on Gender equality, diversity and inclusion.[36] This report argues that te full participation of communities and Indigenous peoples in scientific research is integral to establishing the connection between science and society (p. 9). To redress the power imbalance in research with communities and Indigenous peoples, the practice of participatory research has been extensively recommended in the literature as well as by international organisations including the World Health Organisation (Dadich, Moore & Eapen, 2019). Participatory research takes different forms and scope and full participation of communities and Indigenous peoples in research may be impeded by social, cultural and, or legal constraints which limits or excludes indigenous women from participating in decisions and projects that affects them. To the extent that it is ensured that gender equality, diversity and inclusion are integral dimensions of participatory research, the latter may allow for those that are seldom heard in research (e.g. indigenous communities, indigenous women, and people from other underrepresented groups), to share in the scientific process, output, and outcomes. It also provides a pathway to tackling existing inequalities and building local trust in science, and scientific researchers. Given the history of mistrust between researchers and Indigenous communities, the participatory research process has been described as an issue of ethical principle (Kral, 2018). Participatory research should be predicated on the principle of social justice and mutuality - a relationship which seeks democratic involvement, empowerment, local knowledge and expertise, the co-creation of meanings and understandings and the mutual sharing of benefits (Kral, 2018).

The report also argues that the participation of communities and indigenous people in research and development provides an avenue for co-creation of balanced knowledge taking into consideration efforts to decolonize the way in which education and knowledge are acquired (p. 12). This does not only involve the collaboration between developed and developing countries but also partnerships with indigenous people in advanced countries such as the United States of America, Australia, New Zealand, and Canada. The indigenous people in these countries share a history of colonization and are still being oppressed and disempowered to maintain the dominance of the major ethnic groups over them with the resultant impact of poverty, poor health outcomes and lack of access to education and other services (Lin et al., 2020). These groups need to be included in scientific research, especially when this research is directly relevant for their communities. Collaborations and partnerships with local communities and indigenous peoples in research can help researchers gain access to the study site, indigenous knowledge, and enriched research (Popkin,

[36] Archibong, U., Eshareturi, C., Utam K., Agu C.P. (2021) Mapping the Recommendation for Science and Scientific Researchers (RSSR) to the Sustainable Development Goals (SDGs): Gender equality, diversity and inclusion (UniBrad Team report).

2016). However, this relationship may become problematic given the history of mistrust between natives and researchers. It is therefore crucial for researchers to ensure that collaborations are built on mutual sharing of responsibilities, knowledge, and benefits in such partnerships.

In a final RRING team report on public and stakeholder engagement,[37] although the role of indigenous groups is not explicitly addressed, there is a consistent emphasis on the importance of inclusion of under-represented groups, to ensure a more comprehensive perspective on science and innovation and to ensure that outcomes are beneficial rather than harmful or detrimental to vulnerable and under-represented groups. Cultural and scientific cooperation should include full participation of the communities concerned, to ensure engagement and benefit sharing (p. 8). An important additional consideration is that, although, as the RSSR argues, "appropriate metrics" and "independent peer review" are important (p. 10), this report argues that these conventional metrics should be complemented with "more inclusive and qualitative" indicators of engagement (p. 6).

8. Provisional conclusion

As indicated in the introduction, RRI wants research to be conducted *for* society by involving societal stakeholders in the process of knowledge production (*with* society). Research and innovation must be undertaken to achieve socially desirable and acceptable ends (the product dimension of RRI), by making it more participatory and inclusive (the process dimension of RRI). Increasingly, the Sustainable Development Goals are used as a scaffold for assessing societal impact, i.e. for visualising the extent to which research and innovation work for the benefit of society and foster society's capacity to address societal challenges. In other words, the SDGs allow research performing organisations, notably universities, to measure, determine and enhance their societal impact. Here again, however, goals and results (the "product" dimension of RRI) remains intimately connected with the "process" dimension, such as inclusiveness and participation.

SDG dashboards are created and metrics are developed to visualise the impact of universities in terms of SDGs, even resulting in international rankings. Such data visualisations are doubtlessly relevant, for various reasons. They make researchers and research organisation more aware of their involvement in fostering sustainability goals. In addition, such visualisations may serve as a measure of progress for RPOs who are consciously reorienting their work from traditional quality indicators (e.g. number of publications, citations, research grants, or even the number of CEOs of companies among the alumni, etc.) towards societal impact.

As was outlined in this report, whereas the RSSR urges us to combine appropriate metrics with independent expert assessment (peer review) of the individual's outputs (p. 10), the methodology of impact and inclusiveness assessment should broaden its scope beyond traditional quantitative approaches. In order to assess the extent to which research and innovation are genuinely responsive and inclusive, metrics, quantitative indicators and dashboards must be complemented by a broader spectrum of methodologies, focussing on actual practices of inclusion or exclusion in context.

To elaborate this, we discussed the case of indigenous knowledge. Although in quantitative terms indigenous people account for about 5% of the world population, there position deserves special attention for various reasons. First of all, they constitute vulnerable groups. Not only because they account for nearly 15% of the world's poor, but also because their cultural practices, ways of living, forms of knowledge and natural resources are under threat. Their existence is threatened by climate change and loss of biodiversity, while they suffer disproportionately high levels of land insecurity, social dislocation and violence. At the same time, they are the custodians of unique and vulnerable ecosystems and natural resources. In addition, indigenous forms of knowledge represent a unique

[37] De Castro, F., Kgwadi B. *Mapping the RSSR to the SDGs: Team Report on Public and Stakeholder Engagement*.

intellectual and moral resource for addressing environmental and socio-political crises. The inclusion of indigenous knowledge requires a decolonisation of knowledge production systems. In traditional quantitative approaches, these contributions and resources may be underrepresented. Therefore, in order to foster the SDGs, RRI requires methodological pluralism, acknowledging that various forms of knowledge are connected with various value systems, and that indigenous knowledge is practical, experiential, narrative and contextual, rather than quantitative. To incorporate this wealth of knowledge and experience, we need radical methodological innovation, which superseded various traditional divides, such as between facts and values, or between technological innovation and the dynamics of nature. Whereas in the past research and innovation often resulted in "epistemicide" (the systematic elimination of rival local knowledge systems), RRI should aim to make research sensitive to cultural context and multiple knowledge forms.

Chapter 8: Discussion

As indicated in the Introduction, this RRING Deliverable aims to align and integrate the *Recommendation on Science and Scientific Researchers* (RSSR) and the 17 United Nation's *Sustainable Development Goals* (SDGs). The RSSR is an international standard-setting instrument that calls on governments to create conditions that will enable science to be practiced ethically and fairly, and to be useful and relevant to society (UNESCO 2017). Science and technology-based innovation processes are central to the realization of many of the 169 SDG targets (World Economic Forum 2020). However, as the history of research and innovation shows, the development and application of new scientific solutions is rarely without problems. These include, for example, the surfacing of new types of risks, including for human health, unintended societal implications, and possible adverse effects on the environment and ecosystems (p. 8). The RSSR has a crucial role to play in addressing and preventing these and other challenges, also in the context of the SDGs. In this Deliverable we argued that the integration of the RSSR into science-based efforts to achieve the SDGs offers new ways and perspectives that can help to improve the implementation of the SDGs, and to make the realization of the SDGs more responsible, ethically robust, and aligned with the needs of communities and the environment (p. 8). In this section, we want to summarize the main lessons learned. The following paragraphs will discuss eight areas in which the RSSR can contribute to the SDGs and SDG implementation.

1. Facilitate anticipation of the social and ecological impacts, risks and possible side effects of science-based solutions to achieve the SDGs

Although in principle research and innovation intends to be beneficial to society, possible challenges and drawbacks must be considered as well. First of all, the development of science and technology-based solutions to realise the SDGs is often based on the assumption that these applications will be overwhelmingly positive, and transform societies in beneficial ways (p. 24). However, many S&T-based approaches that can help to achieve the SDGs can also create problematic consequences. These include, for example, possible short-to-long-term effects of technologies on human societies, vulnerable groups or eco-systems, dual use applications, or the misuse of technologies, including for illicit or "rogue" purposes. Overemphasising the promissory potential of scientific research to realise the SDGs can prevent inclusive engagement and anticipatory identification of moral risks. Moreover, in some instances, RPOs and companies may strategically exploit the potential of new technologies to achieve the SDGs, and to use the aspirations of the SDGs to mobilise public support and legitimise the use of controversial technology developments, while downplaying potential problems, risks and uncertainties (p. 24).

These potential downsides must be addressed by facilitating comprehensive anticipation of the social and ecological impacts, risks and possible side effects of science-based solutions to realise the SDGs. They also require that research and innovation processes are more interactive and participatory, and more responsive to societal needs and concerns. As we have shown at the examples of SDG2 (food security and sustainable agriculture), SDG9 (industry, innovation and infrastructures) and SDG13 (climate changes), the use of AI, robotics, big data or also gene editing and other advanced biotech solutions, can disrupt livelihoods, communities, existing production and farming systems, and cause other challenges and side effects that require careful consideration (p. 24-27).

The RSSR recognises and addresses these challenges. Several passages of the RSSR refer to the need to examine and forecast the effects of scientific research on societies, social groups and individuals, including human research subjects. In this regard, the RSSR requests an enhanced spirit of responsibility towards humankind and the environment (p. 19). It demands, for example, "vigilance as to the probable and possible social and ecological consequences of research and development

activities" (p. 23), and the need to protect and enhance "the well-being of citizens in the present and for future generations" (24, 72). The RSSR also acknowledges the dual use and misuse potential of science, and the possibility of illicit and socially problematic applications, which can cause violations to human rights, and hurt individuals and communities (p. 28). In order to address these challenges, the RSSR demands that nation states "develop controls to minimise harms to each living subject of research, and the environment", and to take measures to ensure the health and safety of citizens and communities (p. 24, 67). It also recommends the creation of a social environment that encourages governments, funders and research performing organizations "to take note of and address warnings of hazards and risks" (p. 26). To realise this, participatory and inclusive practices must become an inherent part of the methodology of research and innovation, not only during the implementation stage, but during the whole trajectory of knowledge production. This will be discussed in the next section.

2. Foster open science and inclusive, participatory approaches to advance the SDGs

Responsible Research and Innovation (RRI) is an approach to research and innovation that anticipates and assesses potential implications and societal expectations involved in research and innovation, so as to foster the design of inclusive and sustainable processes of knowledge production. RRI implies that societal actors (researchers, citizens, policy makers, business, third sector organisations etc.) work together during the whole research and innovation process in order to better align research and innovation outcomes to the values, needs and expectations of society (p.4). The RSSR likewise endorses a commitment to inclusive research and development.

As we will discuss below, it emphasises (a) equal access to science education and careers, and (b) broad access to innovation benefits. But the RSSR also stresses a third dimension, namely the willingness to also make the *process* of knowledge production and innovation more inclusive and open to society. An important way to promote inclusiveness is through active mutual engagement of scientific communities with society and local communities (p. 14). The RSSR calls in this regard, for a "vigorous and informed debate on the production and use of scientific knowledge", "consultation with communities where the conduct of research may affect community members" (p. 26, 42) and an ongoing "dialogue between the scientific community and society" (p. 14; 29).

The development of inclusive research and innovation requires an environment that supports broad and open debate, public scrutiny, evidence-based assessments and democratic accountability (p. 29). Scientific knowledge is a public good, not only in terms of outcome, but also in terms of process, as proposed by the so-called AIRR or process dimensions of RRI (anticipation, inclusion, reflexivity and responsiveness (Owen et al 2012). Thus, the process of knowledge production must become accessible to the community. Societal stakeholders must not be passive recipients of scientific knowledge, but must be able to contribute to production and dissemination of science as active stakeholders (p. 70, 74, 99). This requires a commitment to open science, not only in terms of open access publications of the outcomes of research, but also in terms of a commitment to developing participatory and inclusive methodologies. This requires creating progressive, innovative and inclusive channels of communication to allow co-production of knowledge across different sections and cultures, so that science becomes more open and accessible to society, as up-stream as possible. By taking multiple experiences, voices and perspectives on board, and by making full use of public intelligence and public knowledge, society will be allowed to participate in co-producing scientific knowledge. Special attention should be given to indigenous knowledge, not only because indigenous communities are often marginalised and vulnerable, but also because, as custodians of unique ecosystems and interactive practices, they represent important cultural, epistemic and normative resources that must be taken on board.

The active involvement of society will make science more inclusive and responsive to societal needs (p. 82). Innovation (e.g. technological, industrial and infrastructural innovation) should not only be acceptable to society in terms of outcomes, but should include the views, needs and concerns of societal stakeholders for the very outset as an inherent dimension of responsible research and development (p. 88). While, as the RSSR argues, "appropriate metrics" and "independent peer review" are important (p. 10), we argued that conventional metrics and quantitative indicators should be complemented with more inclusive and qualitative indicators of engagement (p. 6). In short, the goal of RRI is to make research and innovation more inclusive. This means involving societal actors in long-term mutual learning endeavours, where both RPOs and the societal environment are considered as learning environment or systems. Via active outreach, citizens and NGOs become involved in research as a learning process. Moreover, via innovative, inclusive and responsible education, future academics are empowered to flourish in interactive and inclusive research (p. 88). Thus, promoting inclusive and responsive innovation will further SDGs (p. 95).

3. Make decision-making on the selection, funding and implementation of SDG strategies more transparent, inclusive and democratic

The development of S&T-based solutions to realise the SDGs is characterized by substantial conflicts of interests. Companies, governments but also scientists and NGOs have often strong incentives to lobby for – or push for – adoption of a particular technology or approach, even though other pathways to achieve the SDGs may in fact be better suited, or more effective, or more affordable. This means, there is clear potential for corruption and the exertion of undue influence, in order to steer decisions on specific SDG strategies. In addition, considering that international development takes place across significant power inequalities, there is a danger that firms and other stakeholders from high income countries, will try to dominate decision making around the SDGs (p. 29).

The RSSR recognizes and seeks to address these challenges in various ways. For example, it demands a commitment to evidence-based decision making, and the full disclosure of "actual and perceived conflicts of interests" of researchers, firms and other stakeholders that fund, govern or benefit from research. It also demands measures from governments that safeguard researchers from "undue influences on" or other attempts to affect "independent judgment" and decision making (p. 29, 79). Moreover, the RSSR promotes freedom of speech and the right of researchers and other stakeholders to express themselves freely and openly on the ethical, social or ecological value and risks of certain projects (p. 80). As mentioned in the previous section, it also calls for the adoption of participatory approaches to decision making, that include stakeholders from societies, including indigenous groups and other marginalised communities.

These requirements - are of fundamental importance to the implementation of the SDGs. Conflicts of interests, powerful lobby groups, and incentives to steer innovation decisions into a specific direction, exist in the context of many SDGs. Examples are: SDG3 - decisions around the development of new medicines or medical technologies; SDG7 - decisions around investment in renewable energies, and alternatives to fossil-fuel technologies; or SDG9 - decisions on more "sustainable transport systems". Many of the technologies or approaches that compete with each other in these areas, represent multi-billion Euro markets, with companies and researchers whose technologies and products are ultimately adopted, making huge profits. Considering the high stakes nature of decisions in these and many other SDGs, the RSSR's demand for inclusive, open and democratic decision-making processes, are a critical requirement to ensure that science-based solutions to the SDGs are implemented in fair and transparent way.

4. Achieve responsible and fair international research and development collaborations

Another way in which the RSSR can contribute to the SDGs is by facilitating responsible and fair international research and development collaborations. International collaborations – in research and business - are central to the realization of the SDGs. Cooperation with private sector stakeholders is seen as particularly important. While international partnerships have the potential to create many advantages, there is also a long history of failed or problematic projects in international research and development.

Problems that have emerged include, the misuse of unequal power relations, the exploitation of vulnerable groups, unfair agreements and failures to share benefits, but also disregard of local needs, perceptions and communities. There have also been cases of so-called "ethics dumping", where researchers or companies went to poorly regulated countries, to conduct research that is prohibited or more strictly regulated in their home countries (p. 30). Similar problems can also surface in the context of partnerships around the SDGs.

The RSSR recognises many of these problems, and has dedicated a long list of criteria that shall help to govern international science partnerships. These include demands for governments to ensure (i) that researchers comply with laws and regulations in different countries, as well as international standards and human rights, (ii) that there is rigorous ethical review in both sponsor and host countries, (iii) that there are clear agreements for benefit sharing, (iv) that projects contribute to the growth of indigenous capacities, (v) that there is engagement with local communities and stakeholders, (vi) that research or development projects are responsive to the needs of host countries, (vii) that research collaborations contribute to the development of local capacities, and others.

A systematic engagement with these requirement – is relevant for many, if not most, SDGs. International drug trials that are conducted in the context SDG3 (on health, wellbeing and health care) are an example. These partnerships can raise issues about the protection of human research subjects, access to medicines, after a new drug has been tested, or also concerns on biopiracy. But there are many other SDGs, for example SDG14 (on the sustainable use of oceans) or SDG15 (on the sustainable use of land and forests) where international collaborations can create problems. A commitment to participatory approaches, and the integration of local needs and local knowledges (including indigenous knowledges) in these and other SDGs, as the RSSR promotes, is and will be essential to successful outcomes of international partnerships.

5. Ensure broad and equal access to the benefits of SDG- related science and innovation processes

Fair and equal access to the benefits, outcomes and products of innovation processes is a key priority of both, the SDGs and recent thinking about responsible research and innovation. The RSSR shares this commitment. It states for example, that "member States should demonstrate and take action such that R&D is not carried out in isolation but as an explicit part of the nations' integrated effort to set up a society that will be more humane, just and inclusive" (p. 24) and that "benefits resulting from any research and its applications are shared with society as a whole and within the international community, in particular with developing countries" (p. 21, 35 and 75). It also clarifies that "the scientific and technological knowledge and its potentialities be promptly geared to the benefit of all peoples", and that "equal access to science and the knowledge derived from it" is an essential "social and ethical requirement for human development, [and] for realizing the full potential of scientific communities worldwide" (p. 34, 48).

However, considering the continued existence of inequalities between and within societies and the current impact of the Covid pandemics, fair and equal access to the outcomes and benefits of innovation processes remains a major practical challenge, also in the context of activities and projects that aim to realise the SDGs. This is especially the case for innovations that are costly for societies to implement, or that are affordable only to a smaller group of wealthy citizens, as is often the case with expensive medical technologies or treatments, which remain unavailable to many.

SDG targets whose realisation relies on international technology transfer, and the involvement of the private sector, require particular consideration of whether innovation benefits will be available widely or contribute to local development and indigenous capabilities. The RSSR form in this regard an important normative framework that allows citizens, stakeholders but also governments around the world to highlight the responsibility of research performing organizations, including firms and multinationals, to consider issues of access and justice. The RSSR's dedication to social and global justice, benefit sharing and broad and equal access are backed up its commitment to the international framework of human rights (p. 73, 74).

6. Accomplish equal access to research opportunities and careers in projects that tackle the SDGs around the world

Fair and equal access to education in STEM and sustainable research careers remains a key challenge. In STEM areas women are a minority, and equal representation of many other under-represented groups in in both science education and careers is far from achieved (p. 60). Moreover, many researchers work under precarious conditions. Equal opportunities for education and access to research careers is a central tenet of the RSSR. It demands equitable conditions of work, recruitment and promotion, without any form of discrimination and exploitation (p. 70). It also requests equal access to knowledge through open access and open data, which is a key requirement to close educational gaps and achieve new opportunities for research careers, especially in developing countries (p. 44, 48)

These demands are relevant to all 17 SDGs. They are a necessary condition to achieve inclusive growth for all (SDG8), reduced inequalities within and between countries (SDG10), and of course to realize gender equality (SDG5) and ensure inclusive and equitable quality education (SDG4) (p. 61). But they are also a prerequisite to achieve equal participation of stakeholders from around the world into deliberation and decision-making processes around the SDGs, including for SDG16 (building of strong institutions) and SDG17 (partnerships for the goals) (p. 52, 63).

7. Strengthen a commitment to gender equality, diversity and inclusion in research and development initiatives that aim to achieve the SDGs

Historically evolved patterns of gender inequality, and other forms of exclusion require actions from state and non-state actors to eliminate biases, transform past inequalities, and create more just and inclusive societies (UB p. 8). The full participation of communities, indigenous peoples and other under-represented groups in the planning and conduct of scientific research is an integral part of this process, and a precondition to strengthen the integration of science into society, and to redress existing power imbalances in research and development, which can cause failure and lack of alignment with local needs, perceptions and customs (UB p.9).

An important aspect of this, is the inclusion of traditional, indigenous and local knowledge sources, which make research and both local and international development activities sensitive to cultural context and multiple knowledge forms (p. 104). Therefore, achieving the SDGs, requires a decolonisation of systems of knowledge and methodological pluralism, which acknowledges the value and role of plural forms of knowledge and value systems as a necessary precondition (p. 104).

However, as chapter 2 clarifies, full participation of communities and Indigenous peoples in research may be impeded by social, cultural and, or legal constraints. These can limit or exclude women or other sub-groups from participating in decisions and projects that affects them (UB p. 9). The RSSR acknowledges these challenges by requesting the elimination of biases against women and persons of under-represented groups, and by giving special attention to the value and acknowledgement of indigenous, traditional and other local knowledge forms (p. 94).

8. Develop research and development projects that respect human rights and prevent exploitation, coercion or discrimination

A central feature of the RSSR is that it anchors research and development processes into the international framework of human rights. This involves a commitment to universal principles, such as freedom from exploitation, discrimination, coercion or other forms of oppression that cause human suffering and pose a threat to communities and international peace. These rights form crucial instruments in the prevention of misuse or harmful effects of science, and its applications (p. 67). But the human rights basis of the RSSR also strengthens its commitment to defend basic political rights, such as freedom of expression and freedom of thought, conscience and religion, which enable scientists and other stakeholders to speak truth to power, and at the same time to respect the value and importance of epistemic pluralism and the inclusion of multiple views and values in innovation processes(p. 81, 82, 83). In addition, the international human rights framework supports the RSSR's demands for many other aspects discussed above, in particular equality and equal access to research benefits, gender and community rights, education and labour rights, and protection of the interests and rights of future generations (p. 66-76)

Human rights are essential tools to the responsible, ethically robust and socially focused realization of the science based strategies to achieve the SDGs. While some human rights principles such as gender equality or the right to health are themselves reflected in the SDGs, the integration of human rights into the RSSR provides a legal basis to hold researchers and research performing organizations and other organizations that fund or govern research accountable of their actions. This is especially important, because the RSSR as a form of international soft law, does not create a legally binding obligation on UNESCO member states, but encourages them to "adopt a particular approach or to act in a given manner in a specific cultural sphere".[38]

[38] http://www.unesco.org/new/en/culture/themes/illicit-trafficking-of-cultural-property/unesco-database-of-national-cultural-heritage-laws/frequently-asked-questions/international-legal-instruments/

Chapter 9: Recommendations

These recommendations aim to ensure that the alignment process of the RSSR and the SDGs, which has been initiated in the context of this Deliverable, will be developed further and implemented by diverse stakeholders in SDG-related research and development initiatives.

Recommendation 1: Clear and appropriate conceptualization

The significance, role and possible contributions of the RSSR to the SDGs must be clearly defined and communicated in appropriate ways to the diverse stakeholders, networks, institutions and communities in which the RSSR shall be embedded and applied. This should include a clear articulation of the benefits of implementing the RSSR, tailored to the needs and priorities of different types of actors and organizations involved in the funding, governance, conduct or commercialization of research (e.g., academic research communities, business and industry, civil societal organizations, policy makers, etcetera). Because the RSSR is a multifaceted instrument that addresses a broad range of issues, communication strategies should focus on specific areas of the RSSR, and discuss their significance in greater depth. The use of illustrative cases and examples that clarify why the RSSR matter to the SDGs, could also be considered.

Recommendation 2: Dissemination and awareness creation

(i) Dedicate budget and resources to put initiatives in place that help to promote the RSSR and its value for SDG-related projects among scientists, industry innovators, government bodies, decision makers, NGOs, the general public, and other stakeholders. One possible way to disseminate information would be via the UN and Agenda 2030's online platforms, for example, on the Partnerships for SDGs online platform, the 2030 Agenda Partnership Accelerator, the SDG Media Compact Platform, or websites of other international organizations, that support the realization of the SDGs. A complementary option would be to disseminate information on the RSSR via the UN's SDGs in Action App, or similar apps.

(ii) Collaboration with media organizations, creative agencies, and other organizations who are committed to the SDGs, and who can lend their expertise to support the integration of the RSSR and the SDGs, or who can promote the RSSR at a more general level, would also help to make the RSSR more known and to create awareness among targeted audiences. The UN follows this approach to promote the SDGs.

(iii) Nominating prominent scientists, decision makers or CEOs from companies to promote the RSSR and their relevance to the SDGs, acting as role models, could also help to raise awareness and facilitate emulation by other researchers, firms or organisations.

Recommendation 3: Ongoing, collective operationalization of the RSSR in relation to the SDGs

Facilitate the collective operationalization of the RSSR in relation to the SDGs, with the aim to create case-specific pathways and procedures that will enable implementation of RSSR aspects across diverse research and innovation contexts. Operationalization of the RSSR in relation to specific STI areas (e.g., digital technologies and automation, biotechnology, etcetera), should also be considered. This could be done through a variety of measures:

(i) Deliberation on the integration of the RSSR and the SDGs with the United Nations High-level Political Forum on Sustainable Development (HLPF), and/or the UN Interagency task team on STI for the SDGs (IATT), or other relevant organizations.

(ii) Discussion of the role of the RSSR in relation to the SDGs at the annual meetings of the UN Multi-stakeholder Forum on Science, Technology and Innovation for the SDGs, the UN ECOSOC Partnerships Forum, or other events.

(iii) Operationalization of the human rights-based approach in the RSSR and its relevance to the SDGs with human rights organizations, such as the UN Human Rights Office of the High Commission, the UN Human Rights Council, or with treaty based human rights bodies such as the Committee on Economic, Social and Cultural Rights, or the Committee on the Elimination of Racial Discrimination, or other relevant organizations such as Human Rights Watch.

(iv) Initiating collaborations by funding agencies and other government departments (e.g., science, technology of innovation, and/or business, development, etc.) across countries, and continents, to collectively reflect on the possible integration of the RSSR into national funding programs and policies, and the RSSR's contribution to enhance STI-based strategies to achieve the SDGs.

(v) Organize large-scale seminars with stakeholder from varied backgrounds in different world regions, that discuss regional and context-specific challenges to the implementation of the RSSR and possible solutions on how to address these.

(vi) Monitoring problems with the realization of STI-based solutions to the SDGs, and using these as case studies to illustrate the value and possible benefits of the RSSR.

Recommendation 4: Educational programs, training and consultancy

The development of educational programs, training workshops and consultancy services to universities, companies, funding agencies and other stakeholders can help to ensure that the RSSR will be embedded in science-based strategies to achieve the SDGs from an early stage. These educational activities should provide clear information on pathways and methodologies through which aspects of the RSSR (such as for example consultation with communities) can be integrated into research projects. In principle, these forms of training, consultancy and other services can be provided by third party organizations on a commercial basis, such as for example ORBIT, even though the commercial character of these organizations is likely to prevent broad access, especially by researchers in developing countries.

Appendix A

Table 1 - data and themes that emerge from the coding of the RSSR[39], [40]

[Insert here: Team Theme (e.g., Open Access/Open Science), Names of Team Members & Affiliations]

Identified aggregate codes (broader analytical themes that relate to the overarching theme that each team explores	Sub-themes that relate to the aggregate code (including brief explanation if relevant)	Text excerpts (copy and paste from RSSR)	Location in RSSR (page & paragraph Nr, etc.)	Related thoughts and ideas

[39] **Guiding Questions that shall help to structure the coding of the RSSR document:**

- How are RRI ideas defined and operationalised in the RSSR? Which concepts, principles, recommended procedures, goals, etcetera are mentioned?
- Which recommendations and implementation strategies does the RSSR provide, to support the adoption of RRI concepts in research and innovation practice? How useful are these to facilitate the integration of RRI (or RRI-like) aspects into the SDGs?
- What references does the RSSR make with regard to the SDGs? And how does the RSSR define the role of RRI (or RRI-related) ideas with respect to the realization of SDGs, if at all?

[40] Please summarise the key findings of this analytical step in Section 2.1. of this Report above.

Table 2 - Linking the RSSR to the 17 SDGs [41]

[Insert here: Team Theme (e.g., Open Access/Open Science), Names of Team Members & Affiliations]

RRI issues / themes Identified in the RSSR (PLEASE TRANSFER FROM TABLE 1)	**Relates to the following SDGs / aspects of each SDG (DESCRIBE EXISTING CONNECTIONS, DISCONNECTIONS & POSSIBILITIES TO CREATE NEW CONNECTIONS)**	**Generating Ideas for Recommendations: How can identified connections and possible new connections be strengthened and developed? How can identified disconnections be overcome, so that SDGs can be achieved and implemented more successfully?**
RRI issue / theme 1 (please describe the issue / theme, and clarify to which aggregate code in Table 1 the theme relates	SDG1: Aspect a	
	SDG1: Aspect b	
	Etcetera	
	SDG2: Aspect a	
	SDG2: Aspect b	
	Etcetera	
	SDG3: Aspect a	
	SDG3: Aspect b	
	Etcetera	
	Etcetera	
RRI issue / theme 2 (please describe the issue / theme, and clarify to which aggregate code in Table 1 the theme relates	SDG1: Aspect a	
	SDG1: Aspect b	
	Etcetera	
	SDG2: Aspect a	
	SDG2: Aspect b	
	Etcetera	
	SDG3: Aspect a	
	SDG3: Aspect b	
	Etcetera	

[41] Please summarise the key findings of this analytical step in Section 2.2. of this Report above.

RRI issue / theme 3 (please describe the issue / theme, and clarify to which aggregate code in Table 1 the theme relates	Etcetera	
Etc.		

Table 3 – Developing Recommendations[42]

[Insert here: Team Theme (e.g., Open Access/Open Science), Names of Team Members & Affiliations]

To which SDG(s) do the recommendations in the next column apply? Please provide the specific SDG number(s); please also provide more general recommendations that apply to all SDGs (or specific groups of SDGs).	**Generate recommendations that provide new ideas, perspectives or approaches that can help to facilitate the integration of RRI+HR aspects in the SDGs, to make them more achievable.**	**At what level and by whom can / shall each recommendation be applied: (i) national and international policy (making)?, (ii) future research and innovation projects (in industry? in academia?), (iii) education and training of researchers, policy makers and other stakeholders?, (iv) other? Please explain and provide details.**	**How can the suggested recommendations be implemented in practice, and which obstacles need to be overcome?**
General Recommendations (clarify: for all SDGs? For some?)			
SDG1			
SDG2			
Etcetera			

[42] Please summarise the key findings of this analytical step in Section 3 of this Report above.
