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联合国教育、
科学及文化组织

Guidelines[1,2] on Sustainability Science in Research and Education[3]

Preamble

"Achieving sustainable development is the overriding challenge of the 21st century" (President of the UN General Assembly 2013). Achieving sustainable development will mean "that all human beings can fulfil their potential in dignity and equality and in a healthy environment" (A/RES/70/1). The United Nations Agenda 2030 for Sustainable Development lays out 1) the global and local challenges mankind is facing with a view to the needed transformation towards sustainable development and 2) how the UN Member States have agreed to address these challenges.

Global and local sustainability challenges are often called "wicked problems". Because they are the result of interdependencies between societal, economic, environmental and cultural drivers that lead to dynamic and mutual reinforcement with causes and effects at many geographic and temporal scales, they often seem intractable and are resistant to solution Knowledge about their causes and interdependencies is often incomplete, contradictory, and rapidly changing. It is not uncommon that addressing one of these challenges can result in changing others for the worse. The global and local sustainability challenges imply many conflicts of goals and interests which lead to policy dilemmas that require balance and compromise. To address such complexity and concomitant dilemmas in policy-making and problem-solving new holistic approaches to research on "wicked problems" have emerged in recent years.

Sustainability Science is research and education that result in new knowledge, technology, innovation and holistic understanding which will allow societies to better address global and local sustainability challenges.

Sustainability Science can include disciplinary, interdisciplinary and transdisciplinary science. It can be geared towards the generation of basic knowledge, towards applied technology or towards sociocultural innovation as well as towards new governance or social and economic models. Sustainability Science is an expression of both academic freedom and of academic responsibility towards societal issues.

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[1] "Guidelines on Sustainability Science in Research and Education" is the main output of the international UNESCO project "Broadening the Application of the Sustainability Science Approach" initiated in October 2015 with the support of the Japanese Ministry of Education, Culture, Sports, Science and Technology (Japan/MEXT) to identify good practices and develop policy guidelines to help Member States harness the potential of sustainability science in their sustainable development strategies.
This project aimed to help UNESCO Member States and other stakeholders introduce or reinforce a sustainability science approach into transdisciplinary research and education, to enable them to better respond to global challenges, through three symposia to foster dialogue and collaboration among experts and policy-makers. Based on the joint efforts of UNESCO's Natural Sciences Sector, Social and Human Sciences Sector, Education Sector and Regional Science Bureau for Asia and the Pacific in Jakarta, the project benefited from the guidance of a multidisciplinary steering committee and a drafting sub-committee.
For further information on Sustainability Science, please visit: https://en.unesco.org/sustainability-science

[2] These Guidelines are not legally binding and Member States are invited to implement the Guidelines as appropriate in their national context.

[3] A possible mechanism to facilitate the coordination of the implementation process (including the dissemination of the Guidelines), such as having one or several national coordinator(s), needs to be explored further. Such national coordinators will be associated with all the stakeholders to implement these Guidelines, whether governmental or non-governmental.

Sustainability Science is a user-driven and user-inspired academic research process, building from integrated knowledge from various scientific and societal bodies of knowledge and from territories-based integrated experiences. The Sustainability Science participatory approach involves societal stakeholders from a broad spectrum outside of academia. This approach supports a practice-oriented analysis of problems and the dilemmas they pose to policy- and decision-makers with a view to identifying possible solutions and pathways towards their implementation. This approach often results in the development of options and scenarios for stakeholders and decision-makers rather than in specific policy prescriptions. In many contexts, indigenous knowledge can be relevant, and it is recommended that the diversity of knowledge sought from outside academia specifically takes into account the perspective of women.

Truly successful Sustainability Science does not target individual sustainability challenges alone but, rather, takes into account their character as "wicked problems" to ensure consideration of the interdependence of challenges, their complexity and potential reinforcement, as well as their geographic and temporal contexts, cultural differences and inherent conflicts of goals and interests.

Therefore, Sustainability Science and its scientific methodologies are flexible and adapted to the character and context of specific problems and sustainability challenges while addressing interdependencies and complexities. In this context, Sustainability Science can be instrumental in promoting and implementing the Sustainable Development Goals as set forth in the United Nations Agenda 2030.

Sustainability Science practitioners in higher education and research bring together a variety of methodological expertise and approaches. The distinctive feature of this approach, however, is that often it will be implemented in teams that bring together scientists from multiple disciplines with diverse societal, non-academic stakeholders and practitioners. Such co-production of knowledge can be instrumental to leverage the vast potential of diverse cultural resources to promote sustainability in the wider community through better understanding of and contributing to knowledge, attitudes, values, life styles and narratives.

Sustainability Science has already established itself firmly as a conceptually diverse approach, which is applied to diverse focal areas and levels of analysis in various regions of the world. The Member States of UNESCO have endorsed the approach as part of UNESCO's Medium-Term Strategy 2014-2021. While it is a methodologically diverse approach, there is broad consensus on its research challenges, on the need to pursue transformative knowledge, on the need to address context and scales, and on the need to bridge boundaries within and between science, society, and policy. However, and possibly because of its diversity, there is still a lack of institutional mechanisms to advance the mainstreaming of Sustainability Science in higher education and research, as well as to promote effective dialogue between research, society and policy.

Mainstreaming Sustainability Science in higher education and research will benefit from integrative action on the part of major international forums such as Future Earth, the Belmont Forum, and in particular UNESCO's intergovernmental and international scientific programmes, i.e. IBSP, MOST, IOC, IHP, MAB, IGGP, as well as UNESCO's networks, including UNESCO Category 2 Centers and UNESCO Chairs.

Sustainability Science can be expressed in the following principles:

1. Sustainability Science is specifically responding to the **interdependent, complex and mutually reinforcing character** of natural, social and cultural ongoing, global and local sustainability challenges. Sustainable development, as expressed in the United Nations Agenda 2030, is exactly about the interplay of such challenges.

2. Sustainability Science aims at mobilizing, generating, disseminating and implementing **knowledge necessary to define and achieve sustainability** as a response to such challenges in the concrete contexts of different geographical and temporal scales. Such knowledge includes new technologies and innovative processes.
3. In addition to generating knowledge, Sustainability Science focuses on **solving problems, understanding dilemmas and conflicts of goals and interests**, with a view to move towards more integrated and coherent policy agendas, policy options and foresight scenarios that take into account both short-term and long-term needs.
4. Sustainability Science is crosscutting science by nature, having as a major goal to seek complementary **cooperation** between natural and social sciences, the humanities, the arts and, in particular, to ensure the participation of diverse non-academic stakeholders, through a collaborative process of co-design, co-production and co-management.
5. Sustainability Science is based on both **academic freedom and academic responsibility** towards societal needs.
6. Sustainability Science **requires important new capacities of individual scientists** for integrated critical analysis and foresight; the ability to cope with systems thinking, changing environments, risks and insecurity; and the capacity to recognize and address diverse values as well as conflicts of goals and interests, to empathize and work responsibly and collectively in diverse partnerships. Such capacities need to be strengthened through all forms of education.

Terminology and Meanings: Interdisciplinarity, Transdisciplinarity, Co-Design, Co-Production, Co-Implementation

In the context of Sustainability Science, a number of key concepts are frequently used to describe different scientific approaches. On the following concepts, there is broad consensus within the scientific community:

Science is **disciplinary** when it builds on the theories, methods, approaches, and instruments, which have been historically associated with one academic discipline to observe, analyze, and explain a problem. Disciplines tend to focus on a particular domain of reality/knowledge (e.g., culture, evolution, agriculture, earth history, the chemical composition of matter, etc.) and are usually institutionalized as part of specific departments. However, the history of science has shown that boundaries between disciplines can shift, blur and disappear, as knowledge evolves as part of exchange and discovery, and as scholars use multiple types of methods and techniques that transcend a particular discipline. Science is **multidisciplinary** when the insights from multiple disciplines on the same problem are considered side by side, but are unconnected.

Interdisciplinary science refers to the specific combination of different fields and/or disciplines to frame research questions, to observe, analyze, and explain a problem. Interdisciplinary science aims at cross-fertilization and mutually enriching collaboration between different types of expertise, within and between disciplines. True interdisciplinary collaboration treats all participating disciplines on an equal footing and develops approaches which transcend established scientific fields. The further apart some disciplines are, the more challenging interdisciplinary science is. Empirically, a genuinely interdisciplinary collaboration between the natural sciences, the social sciences and the humanities is still more the exception than the norm today.

Transdisciplinary science, also called **post-disciplinary**, is the methodology that addresses topics across and beyond disciplines, through a comprehensive and holistic framework. In this context, it engages disciplines and interdisciplinary research, but should also consider the collaboration between professional scientists and diverse non-academic stakeholders, either

individuals or institutions, in order to benefit from and contribute to their understanding of a problem and their specific knowledge. Transdisciplinarity involves interaction at every step of a scientific endeavor, including:

- **Co-design:** In the earliest phase of research design, academic and non-academic partners of a transdisciplinary scientific project collaborate to agree on the concrete problem to tackle and what questions should be addressed;
- **Co-production:** Academic and non-academic partners bring together different forms of knowledge, review its relevance, seek to derive new insights from this combined knowledge, establish and test hypotheses, seek and review generalizations, and collaborate in order to develop, among other possible outcomes, achievable scenarios and options for solutions to the problem addressed;
- **Co-implementation:** Academic and non-academic partners collaborate in the implementation of the research results.

Sustainability Science requires adequate scientific institutions, specific framework conditions and the provision of targeted funding to be provided by education policies and STI policies.

Guidelines for such framework conditions are presented below.

Mainstreaming Sustainability Science in Research

In order to meet the challenge of sustainability, all types of research are relevant, if they take into account and respond to the interdependent, complex and mutually reinforcing character of natural, social and cultural ongoing, global and local challenges.

Mainstreaming Sustainability Science first of all requires promoting, among the wider scientific community, a greater awareness of the complexity and interrelatedness of current sustainability challenges. Young scientists in the early stages of their career, as well as professional scientists trained in disciplinary approaches will require capacity building in the knowledge and skills they need to do collaborative research according to the programmatic goals of Sustainability Science.

Also, the capacity of funders, policy makers and civil society stakeholders, who are operating in the field of sustainability, needs to be augmented in order for these actors to participate meaningfully in the approaches and methods of Sustainability Science research.

In addition to capacity-building, there are structural requirements for mainstreaming Sustainability Science. Any form of research on complex issues, whether such research is disciplinary, interdisciplinary or transdisciplinary, usually requires more time and resources than research with focus on a single, rather well-defined phenomenon. Such time and resources need to be considered from the onset of any research and provided with both funding for individual scientists, as well as institutional funding for scientific entities and for fostering and maintaining new networks of institutions.

The requirements for enhanced capacities, for more time, and for increased resources are far higher still for transdisciplinary approaches. The co-design phase, which should include the co-development of problem definition, goals, norms and visions and the establishment of trustful working relationships among the communities of research and of practice, will typically take longer than the inception phase of a traditional academic research project. Relevant stakeholders need to be identified; partnerships, rapport and trust must be built. And this important phase of project development takes time.

Furthermore, the partners in a transdisciplinary Sustainability Science project are likely to have to negotiate the conditions for moving forward together more often. Based on shared interests, project proposals need to be formulated together to ensure that a Sustainability Science project meets the real needs of stakeholders and to ensure their participation and co-ownership in the project.

Because transdisciplinary Sustainability Science always targets long-term sustainable solutions, it sometimes requires a longer period of gestation than what is expected in traditional academic collaborations. Different forms of knowledge and their relevance and compatibility are evaluated; hypotheses are tested and reviewed together. Being solutions-oriented and aimed at triggering transformation, this approach to research builds awareness of the need for flexibility and change, which requires bottom-up processes as well as sufficient time.

Transdisciplinary Sustainability Science also has specific needs when it comes to evaluating and assessing its value and results. In this context, it is recommended to:

- Foresee multi-stakeholder evaluation panels that will be able to both contribute to the scoping of a project and to assess the scientific value and relevance of the sustainability challenge tackled, and the qualifications of the academic and non-academic participants, and the proposed process for engaging them;
- Use established and new types of indicators to assess and monitor the value, progress and outcome of Sustainability Science projects. They may differ from those used for standard academic research, for instance in terms of both processes and timeframes; also, different forms of publication of results might be included in the evaluation;
- Assess different types of trade-offs associated with the implementation of a given approach to solve a particular problem, and how such implementation may affect different groups of stakeholders, including future generations.

Mainstreaming Sustainability Science research requires enabling institutional frameworks and specific actions by governments. An enabling institutional framework is needed at the places of work of researchers, which enables inter- and transdisciplinary collaboration and also career path options, which are conducive to such research and education. Such an enabling framework should be rooted in the normal administrative structure of institutions. Scientific evaluation frameworks should be reviewed for possible adaptation to the requirements of Sustainability Science. In countries where research systems favor disciplinary career pathways, reward systems that would encourage those scientists at an early stage of their career to do Sustainability Science should be encouraged.

An enabling framework is also needed to engage and expand research directly relevant to societal challenges, including through stronger integration of STI policy with other domains of policy.

Finally, and most importantly, it is critical to develop the necessary interfaces between science, policy and society that can help advance sustainability knowledge and action, enhance adaptive management and societal learning, and provide for scientific bases to policymaking and decisions and actions by civil society.

Mainstreaming Sustainability Science in Higher Education

Sustainability Science also requires new approaches within higher education and, possibly, even a fundamental reconceptualization of teaching and learning. The thrust of such a reconceptualization is very much in line with the aims of the “Third Mission” of higher education, which calls for an active partnership between institutions of higher education with

society and the economy. Sustainability Science in higher education is most frequently called Higher Education for Sustainable Development. Its target group consists not only of future researchers, but also of future education professionals and professionals working in other fields of the public and private sector.

The thrust of Sustainability Science in this context is very specific: to generate the expertise, skills, attitudes and values for addressing sustainable development, through a balance between specialized expertise, inter-disciplinary competence, and transdisciplinary engagement. The goal is to academically educate sustainability experts (young students as well as professionals in continuing education) to develop the power of critical thinking and relevant competences they will need to tackle the complexity of the sustainability challenges facing society from local to global levels.

Based on the principles of academic freedom, higher education provides a protected space for independent and historically informed reflections, which is both, oriented towards the generation of new knowledge and towards contributing to meeting societal challenges.

Progress over the past two decades towards establishment of Sustainability Science in higher education is reflected in the inception of degree programs, support programs, and professorships. There is still a lack of bundling and networking such academic expertise in higher education, and insufficient learning from good practice. At the same time, there is urgent need to strengthen methodological development of interdisciplinary and transdisciplinary Sustainability Science in higher education.

Drawing on a host of earlier recommendations and declarations on higher education for sustainable development, the following guidelines can give guidance for decision makers to broaden the approach of Sustainability Science and inter- and transdisciplinarity in education.

1. Higher education institutions themselves, due to academic autonomy in many countries, are the key stakeholders to advance the crucial role of Sustainability Science, and consequently are called upon to seek opportunities, for example to:

- Identify Sustainability Science as a core element of their Third Mission, and using it to enhance their respective academic profile;
- Integrate sustainability, and environmental literacy more broadly, into all programs, curricula and syllabi, from freshmen to PhD students, regardless of discipline, and strengthening adequate career paths;
- Improve the institutional capacity for Sustainability Science education, either through dedicated new chairs, departments, or alternative structures for inter-departmental and program collaboration;
- Strengthen local, national, and international education partnerships, also drawing upon the opportunities of digitization and in particular Open Educational Resources;
- Recognize the equal importance of research and teaching, namely by promoting project-based education and applied research projects, and by recognizing public service;
- Provide incentives for Sustainability Science which, inter alia, reward collaborative work with academics in other disciplines as well as with non-academic stakeholders;
- Introduce concepts such as “Sustainable Campus”, setting long and short-term goals, publishing annual university sustainability reports, and introducing university-wide entrance courses on themes such as sustainability and academic responsibility;
- Encourage and support student-driven initiatives for sustainability, such as student-driven academic courses or non-formal training as well as cooperation of students across different universities;
- Enable the institutional participation of students in the sustainability governance of a university, for instance through service-learning courses;

- Share good practice, in particular through international collaborations, networks and partnerships.

2. **Individual researchers and teachers** can make a substantial contribution to fostering sustainability in higher education, inter alia by the following actions:

   - Overcome cultures of disciplinary "silos" by working actively together with experts from other academic disciplines and non-academic stakeholders, both in research and in knowledge transfer;
   - Assure close cooperation between researchers and teachers of Sustainability Science and in Higher Education for Sustainable Development, especially in cases where these functions are separate and distinct;
   - Establish equilibrium between the need for both curiosity-driven and demand-driven research called upon by governments and the society;
   - Expose young researchers to training in Sustainability Science thinking;
   - Encourage further education in sustainability for established scientists.

3. **Governments** could ensure enabling environments for institutions of higher education to promote Sustainability Science, *inter alia*:

   - Revise laws on higher education and revise strategy agreements with autonomous universities to address sustainability;
   - Promote and support new indicators for academic and university performance with regard to sustainability, i.e. competence measurement and campus performance –with reference to the framework of the United Nations 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs);
   - Reallocate funding and introduce new (also non-financial) incentives for inter- and transdisciplinary work, for example award schemes;
   - Revise accreditation schemes, e.g. following the introduction of new curricula;
   - Promote ways of critical self-examination and continuous organizational development which are conducive to inter- and transdisciplinary work;
   - Support (university) teacher training and training of trainers for sustainability.

4. **Society and community** play an important role, since they are both relevant co-producers of knowledge and the target group of Sustainability Science results. In consequence, their interaction with higher education can be improved by the following actions:

   - Equip every individual with the knowledge and capabilities they need to address the challenges of non-sustainability and to actively shape the future, through Education for Sustainable Development at all levels of education, from early childhood education to technical and vocational education and training, and including through informal and non-formal education;
   - Establish and support a vast variety of formats of possible linkages between industry, community, and academia;
   - Gear science communication and the "public understanding of science" towards more interactive approaches, including the development of networks to support interaction among isolated actors and territory-based sustainability science projects engaging all relevant stakeholders;
   - Facilitate the engagement of individuals in citizen science and collective action initiatives, whereas individuals and communities contribute to developing knowledge, monitoring implementation, and assessing progress towards sustainability goals.

North - South - South Cooperation on Research and Education in Sustainability Science

Sustainability is a common challenge in both the global North and the global South. Many countries face the additional challenge that allocations for most forms of research and higher education are scarce. The large majority of nations in the world, particularly in the South allocate well under one percent of the GDP for research. The current established systems, moreover, tend to favor more traditional disciplinary approaches.

To strengthen global cooperation on Sustainability Science, the following recommendations apply:

1. **Broaden support for the Sustainability Science approach:** Decision makers in research and higher education policies, both in the North and in the South, need to be made aware of the strengths and benefits of the Sustainability Science approach, in particular as an instrument to ensure the achievement of the SDGs. UNESCO, Future Earth and funding groups such as the Belmont Forum can have a particular role in awareness raising.

2. **Support for capacity building in the South:** Capacity and infrastructure in Sustainability Science research and education, in most countries in the South, need to be strengthened in order to ensure cooperation on a level playing field. Major academic major clusters such as ICSU, ISSC and CIPSH, have a particularly strong role to play in building capacities at this level.

3. **Diversify funding sources:** Traditional public funding systems, being entrenched in historical arrangements favoring disciplinary research, will need to be reviewed to accommodate the needs of Sustainability Science. At the same time, Sustainability Science can benefit from alternative sources of funding that are more susceptible to new approaches. Development agencies, development banks, private foundations are potential allies for Sustainability Science, enabling innovative dynamics for new ideas.

4. **Establish international systems to promote North-South-South collaboration:** Globalized science, technology and innovation, through international cooperation in research and higher education, find their institutional expression through entities such as the Belmont Forum or some sub-programmes of the EU's H2020 Programme. Similar co-funding programmes specifically designed to encourage participation of countries of the global South or even making it a precondition for funding are needed. Several countries have funding schemes aimed at promoting North-South-South collaboration.

Today, it is recognized that international cooperation in research and higher education is essential to finding solutions to global sustainability challenges. This presents a very real opportunity to strengthen and to promote Sustainability Science – which should be understood as a global effort involving international cooperation wherever possible.

Strategic Funding for Sustainability Science in Research and Education

Since Sustainability Science for several Member States is still a rather new approach, it may be seen as a competitor for scarce resources. The impression of such competition needs to be overcome. Several global studies, including the UNESCO Science Report, have concluded that there are compelling arguments for most Member States to increase support and funding to scientific research and higher education, across the board of disciplinary, interdisciplinary and transdisciplinary work.

Integrating funding mechanisms for Sustainability Science into the established funding schemes of government and funding agencies, alongside funding for “traditional” disciplines,

will support the reputation of Sustainability Science as a high-quality scientific approach. Funding for Sustainability Science requires funding through competitive frameworks, which is a prerequisite for scientific excellence.

Sources of funding should be diversified to include international organizations, government departments, academies, other science-based bodies as well as other sectoral ministries, public and private foundations, and industries. For international cooperation, a stronger involvement of development agencies and development banks, both national and multilateral, could be promising, since Sustainability Science is focusing on problems in practical contexts. In addition, crowdfunding should be explored as a potential option for specific types of projects.

In any case, funding conditions need to be adapted to the collaborative requirements of Sustainability Science. Specifically transdisciplinary approaches, which build on partnerships with non-academic stakeholders, and possibly including partners in diverse countries, may require additional time, both in preparing and in implementing a project. In most cases, foreseeing funding for capacity development is very beneficial.

Consequently, for Sustainability Science projects, funding for the co-design of project proposals including funding participation of non-academic stakeholders on a competitive basis should be considered, and the periods during which calls for proposals are open should be extended. Funding institutions should also consider providing support for implementing results of the project into practice. Co-design elements might even be considered a requirement in certain contexts. Such considerations would apply even more for international research partnerships with low and lower middle-income countries.

Funding should in general encourage methodological flexibility and diversity. In summary, Sustainability Science benefits from a long-term perspective also from funding agencies; funding agencies can also be understood as stakeholders of Sustainability Science projects with appropriate forms of involvement.

Finally, with regard to measuring the impact of a Sustainability Science project, new indicators and measurement approaches are needed for taking into account the assessment of impacts across different time-scales.

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