> CHAPTER 1

Aligning STI with the SDGs

An overview of the complex challenges

AUTHORS

Andy Stirling
Joanna Chataway
Tommaso Ciarli
Pedro Conceição

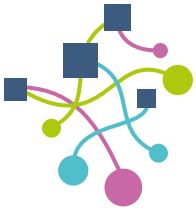
OVERVIEW

This chapter introduces the key ideas at the heart of the STRINGS project. It explores:

- the importance of the Sustainable Development Goals (SDGs)
- the complex relationship between the SDGs and science, technology and innovation (STI)
- the challenge of how to better align STI activities with the goals

It then explains how the STRINGS project aims to tackle some of these complex issues by providing evidence and tools that help to illustrate and better understand misalignments between STI and the SDGs, and ultimately to inform the prioritizing of particular STI pathways in relation to specific SDG challenges.

Footnotes for this chapter are on page 35. A full list of references can be found on page 140.



Multiple directions for progress in STI

Despite much questioning and criticism, the importance of the SDGs in current world affairs is undeniable. Built on the foundations of decades of collective action, social mobilization and civic deliberation, their adoption was the culmination of a process that had been under way for nearly half a century.[1] With a scope and detail unmatched in any other single framework, the goals are unprecedented in their span across social, economic and environmental issues.

Global governance processes have now begun to wrestle in explicit, systematic and accountable ways with the perennial but neglected challenge of 'which way constitutes progress?' The framework of institutions, practices, discourses and metrics around sustainable development has a vital role to play in guiding global progress. The practical policy implications for funding, regulating and investing in research and innovation are profound.

'With a scope and detail unmatched in any other single framework, the goals are unprecedented in their span across social, economic and environmental issues.'

For centuries, 'progress' in STI has been viewed as whatever happens to emerge over time.[2] The tacit assumption is often that research and innovation governance is more about what *can* be done, rather than what *should* be done. Political leaders, for example, might assert that it is the rightful place of science to drive wider social progress, without addressing other drivers of progress or acknowledging that some outcomes of science might have negative impacts. And the commonly held view that one cannot stop scientific progress ignores the many ways in which prioritizing certain kinds of science or innovation inevitably accelerates particular types of progress and curbs others.

Strategies for investing in research and technology worldwide are routinely presented as 'pro-innovation', with little space for debating which particular kinds of innovations are being favoured and by which interests.[3] This narrow modernistic vision of progress ignores contending forms of science, alternative directions for research, and the choices between different innovation pathways.[4]

SDGs enable socially deliberate STI progress

The SDGs have set in motion the building of a shared global framework for holding research and innovation, and all kinds of change, to account. Instead of STI priorities being driven by the most privileged and powerful interests, the SDGs enable and require consideration of other priorities. Instead of research and innovation pathways being viewed as hard-wired, the SDGs encourage an opening up of political spaces, allowing critical questions and greater creativity in relation to how STI can help to achieve sustainability. Instead of rhetoric that these powerfully-backed paths are 'pro-innovation' (and that their critics are 'anti-science'), more nuanced attention can be paid to options, values and interests that may otherwise have remained sidelined.

How different influences shape STI

But what does this mean for scientific autonomy? Do the SDGs threaten to introduce stifling constraints on research and innovation? Any reasonable answer to this question must be no. For all the importance of the scientific values of independence, openness and scepticism, research and innovation have nonetheless always been subject to cultural, political and economic influences. Worldwide, many powerful interests and structures encourage particular directions for research and innovation and suppress others – too often reinforcing existing inequalities.

Overall, those areas of research that offer the greatest potential in terms of private profit, market control, national advantage or military domination tend to benefit from the largest funding streams and the most enthusiastic political and commercial support.[5] It is a reflection of this internal politics of science, for instance, that the largest single area for public STI funding around the world is military and security related.[6]

Political missions are typically focused around specific types of technology as a means to an end (for example, aerospace, nuclear, machine learning, nanotechnology, or gene editing) rather than on the ends in themselves (for example, goals relating to food, water, energy, shelter, mobility or communications).[7] The result has been a tendency to prioritize advanced technology over other kinds of innovation that might be more effective in achieving the SDGs. In food and agriculture, for example, molecular genetics tends to be disproportionately supported, compared with other scientific methods or social, political or behavioural approaches.[8]

Likewise, within science itself, there can be a tendency to prioritize research that focuses on the reductive categories (such as genes or functional molecules), over which intellectual property rights can most easily be exercised. This can lead to the side-lining of research that takes a more societal, relational or systemic approach. Although this type of research can be more difficult to appropriate, it can often be far more effective in addressing the SDGs.[9]

This focus on particular STI categories also means that negative impacts can be overlooked. For example, while there is much focus on the opportunities offered by digital technologies in relation to achieving the SDGs, less attention is given to the extent to which these technologies can drive inequalities by further concentrating data ownership and market power.[9]

It is crucial to recognize that all innovation is at least as much social as it is technological, and that many of the most promising technological innovations in relation to the SDGs are dependent on behavioural, organizational and political change.[10] There is very little that new technologies can achieve on their own.[11]

The role of the SDGs in steering STI

In short, the SDGs offer a means for researchers, funders, policymakers and societies at large to reflect, in fair and accountable ways, on which directions for research or innovation are most likely to count as progress in relation to the SDGs.

However, the most appropriate direction for research or innovation in any given context is typically far from self-evident. There is no sustainability goal or metric so precise that it is not possible for views to legitimately diverge. Thus, prioritizing the directions for STI in relation to the SDGs is an unavoidably qualitative and political challenge.

This does not mean, however, that anything goes. Across all views, some possible directions for science and technology may be quite easily set aside in favour of alternative pathways. This may be especially so in relation to some of the influential drivers of research and innovation that are absent from the SDG framework, such as private profit, market share, national prestige or military dominance.

The role of the SDGs in helping to steer more sustainable STI is not about asserting any specific political agenda, but about defining a shared political space to oversee the current drivers and directions in STI. A full range of scientific disciplines and fields of engineering or wider social practice are free to make the case for why, and under what conditions, particular directions for innovation may offer the best route to sustainability in a particular setting. The important point is for these contending cases to be rigorously scrutinized, rather than simply imposed or assumed in favour of the most powerful interests. This report makes a small contribution towards this end.

Dimensions of complexity around STI and the SDGs

Multiple aspects of the SDGs

Of course, many uncertainties, complexities and obstacles lie in the path of these ambitions. The SDGs span multiple aspects of, and perspectives on, human well-being, social equity and ecological integrity. The 17 goals, 169 targets and 231 indicators are just the visible tip of an iceberg of deeper implications and entanglements between ostensibly discrete issues. Addressing any one of these issues inevitably affects others. The history of technology is replete with examples of powerfully-backed 'solutions' to one problem becoming causes of another, sometimes more serious, calamity.[11] The lessons for research and innovation are profound.

Variety of STI activities and actors

Another crucial factor is the wide scope and variety of STI activities. The category system used by the OECD yields 42 broad fields of STI research and development, each divided into multiple individual topics, disciplines and associated communities of interest.[12] The Institute for Scientific Information's classification scheme, as used in this report, divides science into 254 subject categories, each with its own priorities,

Figure 1.1 / Dimensions of complexity

SUSTAINABLE DEVELOPMENT GOALS

17 Goals | 169 Targets | 231 Indicators

DIVERSE INFLUENCES ON STI

Individuals and communities of researchers, all with their own aims and values.

Institutionalized disciplines, each with their own distinctive understandings and cultures.

[close to]
200 NATION STATES
with a vast array of geographical, jurisdictional and cultural settings

An estimated **108 types of ecosystem**, each with its own implications for relations between society, technology and environments.

Stark differences in power, privilege and capacity

e.g. national governments differ from each other **by a factor of more than 100,000** in the resources they can mobilize.

Priorities for research and innovation are also shaped by governments and businesses, driven by specific interests and politics.

Variations in socio-ecological contexts can affect ability to address many SDGs.

addressed through the contrasting lenses of more than 21,000 academic journals.[13] In the field of technological applications, the International Patent Classification divides technology into around 70,000 distinct areas.[14]

These contrasting fields of science and innovation are comparable in their multiplicity to the complexities of the problems they seek to solve. STI is practised by diverse individuals and communities of researchers, all with their own aims and values. It takes place in a range of institutionalized disciplines, each with their own distinctive understandings and cultures. And the priorities for research and innovation are strongly shaped by governments and businesses, driven by specific interests and politics.

Variations in socio-ecological contexts

Cutting across these complexities are enormous variabilities of context. With close to 200 nation states and even more officially-recognized nationalities in the world,[15] there exists a vast array of geographical, jurisdictional and cultural settings in which diverse forms of research and innovation seek to address a multiplicity of social and environmental challenges.

Beyond this, the world supports an estimated 108 types of ecosystem, each with its own implications for relations between society, technology and environment.[16] To take another important indicator of divergent context, there are now more than 500 cities in the world of more than one million inhabitants, each with its own distinctive history and constituting issues.

Across this bewildering vista, there are stark differences in power, privilege and capacity. The per capita income of the richest countries of the world, for instance, is well over 100 times that of the lowest income countries. National governments differ from each other by a factor of more than 100,000 in the resources they can mobilize, with wealth concentrated massively at the top of this distribution. Production in some sectors is similarly concentrated in a few firms with the highest shares of capital and mark-ups, especially in industries with rapid rates of innovation.

Such inequalities exert crucial influences on the ability to address many SDGs. For instance, countries may differ by a factor of 42 in their neonatal mortality rate; of 10 in the share of population with access to electricity; of 50 in the share of population with access to the internet; of 2,500 in the number of scientific and technical journal articles per 1,000 population; and more than 1,000 in per capita energy related CO_2 emissions. Fairness and equality in and around STI are crucial to achieving sustainability.

Diverse perspectives

One key aspect in achieving greater fairness and equality lies in acknowledging the inherently political (not just technical) dimensions around both sustainability challenges and STI directions. Each one of the multiple permutations of SDG issues, STI possibilities and socio-ecological contexts can be viewed from a plurality of contrasting political perspectives, built on different values, interests and understandings.

It is clear that the number of contending STI 'directions' and 'pathways' to achieve the SDGs extends across many orders of magnitude. Assumptions that only one STI pathway offers a self-evident, sound science or pro-innovation way forward in any given context are clearly mistaken or misleading. Questions are always to be asked over why any research or innovation pathway should be supported more than another, which interests to prioritize, whose values count, and how to hold influential interests to account.

Addressing the challenges of aligning STI with SDGs

Amid such complexities, it is clear that there can be no one-to-one mapping of STI solutions onto problems. There is no shortage of particular interests asserting the sustainability benefits of their own favoured directions for research or innovation. Nor is there any shortage worldwide of mission-oriented agencies addressing specific aspects of the SDGs in terms of their own remits, for instance by asserting claims about what particular technologies can do for sustainability, rather than asking in more balanced ways, which STI directions would be best for specific SDG aims.[17]

What needs strengthening in the governance of science and technology around the globe are tools and resources to support open and inclusive processes of deliberation, focusing on alternative directions for STI in specific settings.[9] There is a need for careful quantification and rigorous analysis alongside attention to uncertainty and variability, so as to stimulate, inform and support a lively participatory worldwide debate.

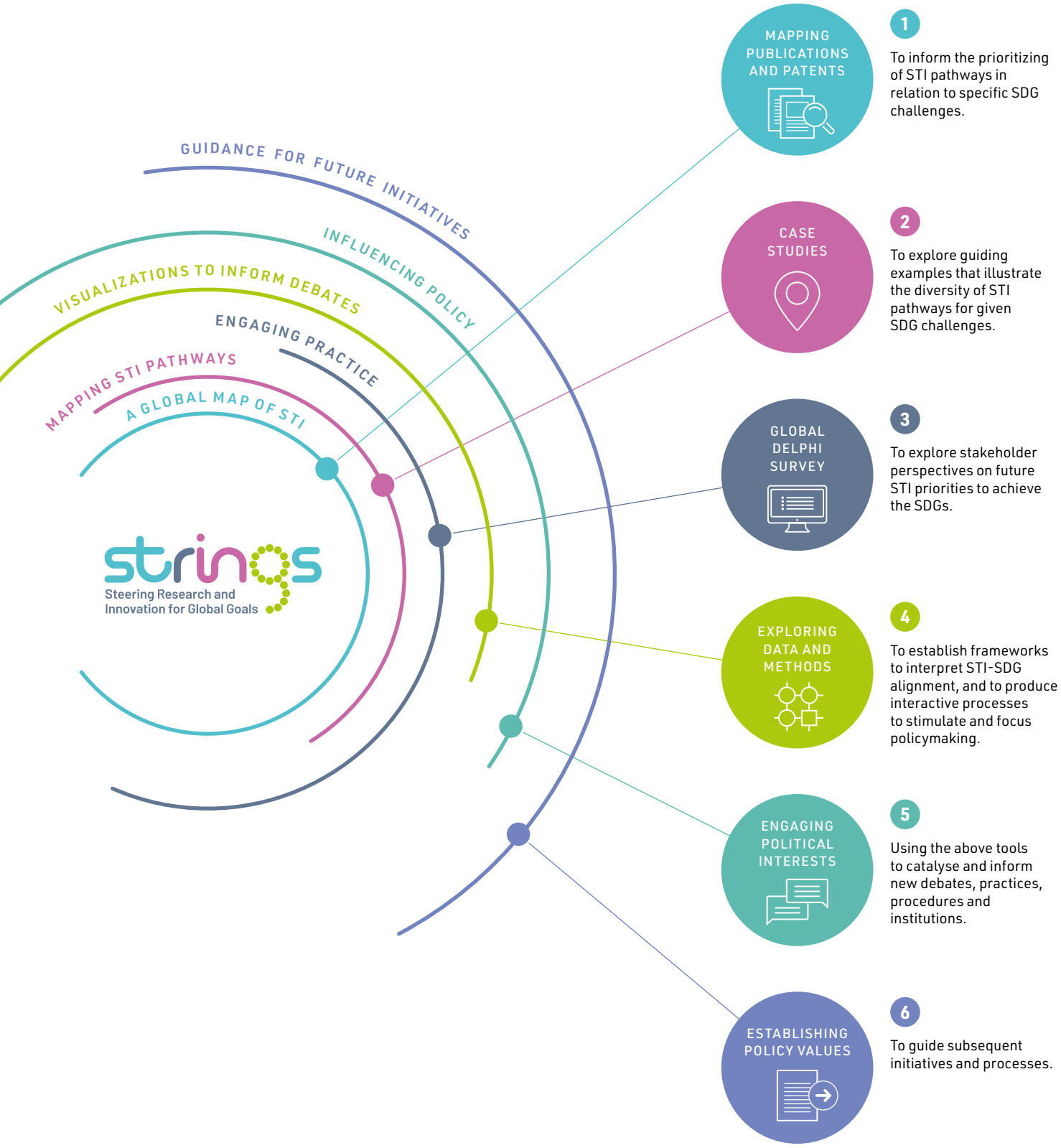
The core aim of this report is to address this need. Building on sporadic prior efforts, we aim to provide new evidence and tools for global mappings, clearer visualizations and better understandings of the alignments between STI and the SDGs. In this way, we seek to open up, motivate and guide international governance attention to the challenge of aligning STI more effectively with the progressive social and environmental values embodied in the SDGs. See pages 34 and 35 for further explanation of the STRINGS project's goals.

Our aim is to enable the appropriate prioritization of the interests of different groups, including those currently unjustly marginalized in global research and innovation, for example, exploited workers, disappropriated landholders, disenfranchised constituencies, oppressed communities, neglected regions and excluded nations especially in the Global South.

Although the challenge of aligning STI with the SDGs is highly complex and intractable, these difficulties need not impede these progressive ambitions. Simply to ask questions about direction is itself a crucial first step. Even relatively incomplete and qualified evidence may prove highly valuable in highlighting the shortcomings of dominant STI pathways in particular settings.

Figure 1.2 / A summary of the goals of the STRINGS project: from concept to implementation

For more detailed information see page 35.



The goals of the STRINGS project

The STRINGS project aims to provide an empirically-based, globally-produced analysis to empower policy action. Our goals are as follows:

1

To produce mappings that inform the prioritizing of STI pathways in relation to specific SDG challenges. Given the pioneering nature of this analysis and its early stage, these initial findings can only be incomplete. They are 'heuristic' guides, rather than definitive prescriptions. The scope and depth of the complexities also lead to a degree of open-endedness. These limitations underscore, rather than diminish, the importance of robust policy appraisal processes. By producing quantitatively rich and qualitatively 'thick' data, this project encourages wider evidence-gathering practices to inform policy.

2

To explore guiding examples, based in particular geographical, environmental and political settings, to yield case studies that illustrate the diversity of STI pathways for given SDG challenges. These case studies also demonstrate how active governance of the alignment between STI and the SDGs can be undertaken using reproducible methods in a range of real-world circumstances.

3

To challenge and interrogate current directions and priorities of STI in particular settings. We do so by asking rigorously about possible future STI directions that might otherwise be neglected; about social and political perspectives on STI that may be currently marginalized; and about the practical value of fostering a greater diversity of STI pathways.

4

To explore data and methods to identify priorities, so as to:

- establish systematic frameworks for questioning directionality and alignment around STI and the SDGs
- pioneer new applications of established or adapted methods
- experiment with novel hybrid approaches (especially combining qualitative interpretive and quantitative analytic practices)
- produce interactive processes and associated visualizations to help stimulate and focus policymaking and wider political attention

5

To contribute to building formative governance networks.

Over the course of the project, we have reached out to earlier and parallel initiatives, involving a diversity of actors and movements that are broadly concerned with the same issues around aligning STI with the SDGs.

Centring around a new global 'platform observatory', our recommendations are to engage policy actors and wider political interests in addressing this central challenge. By using the above tools to catalyse and inform new debates, practices, procedures and institutions within and across government, business, academic and civil society, we aim to aid deliberation, negotiation and the commissioning of further analysis and institution-building.

6

To nurture and benchmark crucial policy values to guide initiatives and processes. These values include:

- **rigour** in addressing neglected challenges of directionality in STI, diversity in STI pathways and pluralities of perspectives
- **transparency** in the clear and comprehensive representation of associated issues, uncertainties and complexities
- **openness** in the inclusion of diverse perspectives, forms of expertise and, as much as possible, data
- **accountability** in the provision of robust justifications for the pursuit of particular STI responses to specific SDG challenges

The scope and complexities of this task mean that it will never be possible to encompass a full or definitive picture of the appropriate directions for research and innovation. Nonetheless, we hope to provide concrete data and practical tools for provoking and guiding the many kinds of onward progress that can meet the challenge of the SDGs.

Notes

1. Brundtland 1987; United Nations Conference on Environment and Development, 1992; United Nations, 2015.
2. Stirling, 2009.
3. Sveiby et al, 2012; Godin and Vinck, 2017; Wright et al, 2018.
4. Government Office for Science, 2014.
5. House of Lords, Volume 1, 2010.
6. OECD (a), 2021; House of Lords, Volume 2, 2010.
7. Kattel and Mazzucato, 2018.
8. House of Lords, Volume 1, 2010.
9. Ely et al, 2010.
10. Nicholls et al, 2014.
11. Tenner, 1999.
12. OECD (b), 2021.
13. https://clarivate.libguides.com/webofscienceplatform/coverage
14. https://worldwide.espacenet.com/patent/help/ipc
15. United Nations, 2021.
16. Keith et al, 2020.
17. Miller, 2007.