

GLOBAL SUSTAINABLE DEVELOPMENT REPORT

2016 EDITION
ADVANCE UNEDITED VERSION



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Executive Summary

The following is an executive summary of the Global Sustainable Development Report (GSDR) 2016. Building upon the 2014 and 2015 reports, the current report responds to the mandate from the Rio+20 Conference to contribute to strengthening the science-policy interface for sustainable development in the context of the high-level political forum on sustainable development (HLPF).

The preparation of the report involved an inclusive, multi-stakeholder process drawing upon scientific and technical expertise from within and outside the United Nations. 245 scientists and experts based in 27 countries, including 13 developing countries, contributed to the report. 62 policy briefs were submitted in response to an open call. Twenty agencies, departments and programmes of the UN system contributed to the report with inputs, comments, suggestions or revisions.

Major international conferences and summits in 2015 – on financing for development, sustainable development, and climate change – have defined a new sustainable development agenda for the next 15 years. At all levels, from global to local, attention is turning to implementing this ambitious agenda. This is the context in which this year's Global Sustainable Development Report appears.

Given the adoption of the 2030 Agenda for Sustainable Development with its sustainable development goals (SDGs), the report adopts the SDGs as its scope. True to its mandate, the report is designed as an assessment of assessments. It endeavors to present a range of scientific perspectives and to be policy-relevant but not policy-prescriptive. Like its predecessors, it continues to explore possible approaches and vantage points from which to examine the science-policy interface, as well as scientific approaches that can inform policies building upon integration and interlinkages across sustainable development goals, sectors, and issues.

The report was prepared specifically to inform the discussions at the high-level political forum on sustainable development in 2016. The theme chosen for the HLPF is 'ensuring that no one is left behind'. This theme is a recurring thread in the report. The first chapter asks what 'ensuring that no one is left behind' means in relation to the 2030 Agenda, and provides a framing for other chapters of the report. Those provide specific highlights on how the inclusiveness imperative may impact the delivery of the Agenda, through examining the nexus of infrastructure, inequality and resilience (chapter 2) and through the cross-cutting dimensions of technology (chapter 3) and institutions (chapter 4). As a critical dimension of the science-policy interface, the report also explores ways in which new and emerging issues identified by science could

be screened and analyzed for the benefit of the HLPF and its mandate to provide high-level guidance on sustainable development.

Leaving no one behind and the new Agenda

Ensuring that no one is left behind is a fundamental guiding principle for the implementation of the 2030 Agenda for Sustainable Development. In implementing the Agenda, countries and stakeholders will have to make choices on where, when and how to act. In that process, they have pledged to endeavour to reach the furthest behind first. Fifteen years from now, when the current and the next generations together assess the implementation of the 2030 Agenda, a key measure of success will be the extent to which it has allowed improvement in the lives of the poorest and most vulnerable, regardless of gender, race, age, religion, place of residence or any other factor. Many organizations have started to work on the implications of the call to leave no one behind for the delivery of the 2030 Agenda and for their missions.

Given the importance of this notion in the 2030 Agenda, it is critical that some clarity exists on its implications for implementing the Agenda. At the conceptual level, three main questions need to be addressed. First, who are those being or at risk of being left behind? Second, how can strategies and policies reach them in practice? And third, what types of strategies and policies would be appropriate in order to leave no one behind? Science can inform decision-making on these three broad questions. Through this, it can also provide elements to assess how ambitious and challenging it will be to realize the commitment of leaving no one behind, by revealing to what extent strategies and policies that have been used in various SDG areas are aligned with this objective, and what their success has been in achieving it.

The ambition to endeavor to reach the furthest behind first' is a transformative aspect of the 2030 Agenda. Does this imply different implementation strategies than those commonly used in the past? What could it mean for important cross-cutting dimensions such as institutions and for the way technology is managed? Here also, scientific evidence can inform the debate.

The first chapter of the report explores the implications of leaving no one behind for the operationalization of the SDGs from a science-policy perspective. It examines what 'ensuring that no one is left behind' means in relation to related concepts that are prominent in the 2030 Agenda such as inequality and inclusiveness. It reviews some of the concepts and methods used to identify those left behind and to reach them in practice. Finally, it highlights examples of development strategies used in various areas of sustainable development and what evidence tells us about their effectiveness in leaving no one behind.

Many SDG goals and targets directly relate to leaving no one behind and refer to specific objectives and actions as well as groups (of countries or people) that should be the object of sustained attention in this regard. This is particularly the case with goals that were within the scope of the Millennium Development Goals (MDGs), including poverty, gender, education, health, and means of implementation. In those areas, considerations of inclusiveness in a broad sense have long been part of the main development discourse and practice, and actions and policies to address this dimension have become part of the standard development apparatus.

Many criteria can be used to identify those left behind, whether within a country or between countries. In practice, those “left behind” with respect to a particular dimension of the Agenda may be different groups in different societies. In addition to the reference to certain groups (e.g., women, indigenous peoples, persons with disabilities, the youth, and others) and deprivation indicators focused on single areas or sectors, many indices of multiple deprivation exist, which incorporate social, economic and environmental indicators. For example, the Multidimensional Poverty Index (MPI) published by the United Nations Development Program (UNDP) incorporates ten weighted indicators that measure education, health and standard of living. This and similar composite indicators were created in response to the growing concern over the multiple dimension of poverty. Deprivations tend to be spatially concentrated and, therefore, policies concerned with leaving no one behind need to take into account geography. In this regard, multiple deprivation maps based on composite indicators have been used as an instrument of planning and management at different levels from national to sub-national to local, both in developed and developing countries.

In many areas, inclusive development strategies are the commonly accepted paradigm. Examples include drinking water, electricity and other basic services, where ensuring universal access is often an overarching objective and is now reflected in the SDGs. However, whether strategies succeed in reaching those left behind depend on many factors, from country-specific circumstances to their design, targeting methods and practical implementation. A variety of targeting methods have been used to reach those left behind. All require underlying data systems to be implemented, as well as administrative capacity in various institutions. Available evaluations from different SDG areas all suggest that there are significant practical challenges in effectively reaching those left behind. For example, self-targeting strategies to identify beneficiaries of food subsidies may impose costs on the recipients such as transportation costs involved in taking up transfers or may cause social stigma.

Examples of interventions reviewed for the report that aim to reach the furthest behind first include: nutrition, where the

core target of interventions in developing countries is those suffering the most from stunting; area-based interventions targeting the poorest locations; and strategies to provide shelter for homeless people.

A message comes across strongly from chapters 1, 2, 3 and 4, even though their topics are very different and the scientific communities involved around each of them are distinct: if no one is to be left behind in 2030, the notion of inclusiveness cannot be treated as an afterthought or even mainstreamed in other areas. Rather, it should be an integral part of institution design and functioning; of research and development, and of infrastructure planning and development.

Based on the limited evidence reviewed in the report, over the next 15 years, factoring in the imperative to leave no one behind in sustainable development interventions may not present insurmountable difficulties in many areas of the new Agenda. Undertaking to systematically reach the furthest behind first may represent a much greater challenge and may in some cases imply a more significant departure from present strategies. Doing so is likely to require attention at three levels. First, better taking into account the interests of those left behind will require assessing the way in which strategies and policies are designed. This in turn may require the incorporation of enhanced understanding of the dynamics of poverty, marginalization and vulnerability in a country- and place-specific context. This may also involve ways to give more voice to deprived or marginalized groups in policy discussion and decision-making. The institutional dimension is clearly crucial in this, as argued in chapter 4. Second, there will be a need to review, and possibly update, ways in which strategies are executed, with particular efforts made to reach the furthest behind, addressing gaps in administrative capacity and data to improve the targeting of programmes. Third, at the highest level of decision-making in Government, taking the new Agenda at its word will require a consideration of how social objectives are balanced with other objectives, such as short-term economic efficiency. Ultimately, the priority given to those furthest behind will be reflected in the allocation of resources, both from the public and the private sectors.

Going forward, it will be critical to systematically collect further scientific evidence on how existing development strategies do indeed reach the furthest behind. A first step could be an inventory of existing meta-studies that attempt to review the effectiveness of development interventions in different SDG areas in reaching those left behind. While evaluations do exist for specific SDG areas, they use different criteria for defining and measuring those left behind or furthest behind and for assessing the effectiveness of interventions in reaching them. It could be worth assessing the costs and benefits of investing in

more comparable frameworks for evaluating development interventions in different SDG areas. This would likely be a significant undertaking in terms of methodology and costs.

A nexus approach: The infrastructure – inequality – resilience nexus

Nexus approaches, which examine sets of issues as a whole and focus on the connections between them, have been one of the lenses through which the GSDR has approached the SDGs. The aim is to strengthen the science-policy interface by showing policymakers how key interlinkages are analyzed by the scientific community, while providing the scientific community with key policy questions and highlighting areas for policy-relevant research.

This year's report examines interlinkages between infrastructure, inequality and resilience. These areas relate to several SDGs and have strong connections with inclusiveness and leaving no one behind. Chapter 2 highlights the main channels of interconnection among these areas put forward by 24 contributing scientists from various disciplines and United Nations experts, as well as a review of findings from several hundred publications. Extensive bodies of literature have focused on each of these areas. For example, infrastructure has received significant attention in development circles, due to its perceived critical role in spurring economic growth and development. Yet, scientists focusing on each of those fields typically hail from different communities, making links between the three areas less commonly studied than any of the three areas taken in isolation.

Some of the interlinkages in the nexus have received much more attention from scientists than others. This is illustrated in Figure 1, which summarizes in a simplified way key interlinkages that emerged from the analysis. Areas that are well covered by scientific research are the links between infrastructure and inequality, and how people's resilience is affected separately by inequality and by the resilience of infrastructure to natural disasters. By contrast, although the report consulted with experts from a broad range of disciplines, linkages in which the causal relation runs from resilience to inequality and from resilience to infrastructure were only very marginally or not covered. Further research in these two areas may be needed to document important linkages, synergies and trade-offs.

The interlinkages identified by experts and described in Figure 1 can be summarized as follows. Infrastructure affects inequality through three main channels: the provision of basic services such as water, sanitation and electricity; broad (macro-level) increases in productivity that result from the presence of infrastructure such as irrigation, electricity, ICT, and roads; and (micro-level) effects of infrastructure on the access of people to goods, services and job opportunities. In general, the literature has found

a positive relationship between infrastructure and reduced inequality. However, the specific channel (or combination thereof) through which this occurs is complex, as shown by a large number of econometric, microeconomic and other empirical studies covering those channels. Inequality is affected by the quality, design, coverage, accessibility and distribution of infrastructure. Key elements in this regard are where infrastructure is located, and whom it is intended to benefit.

Inequality affects infrastructure through its effect on the balance of political power, which in turn affects government decisions on the provision of infrastructure. That may result in disproportionately low share of investment being directed to infrastructure that benefits the most disadvantaged, reinforcing and perpetuating social and spatial inequalities. Breaking that vicious cycle may be critical for the implementation of the 2030 Agenda.

The effect of infrastructure on resilience is an area of the nexus that has received much attention by the scientific community. In particular, the literature has focused on how the quality, design, distribution, interrelation and operation of infrastructure affect its resilience to natural disasters, which in turn influences people's resilience to shocks. There is considerable knowledge about resilience to more predictable and lower intensity events, but much less on how to make infrastructure resilient in the case of the more severe disasters. There is also a significant focus of research on critical infrastructure, such as transport networks and electricity infrastructure, which are particularly vulnerable to chain reaction effects during crises.

Inequality of opportunity and discrimination affect resilience through their impacts on social norms, interactions and networks, which have an effect on the ability of people to adapt to shocks. In that context, vulnerable populations are usually the most severely affected. Much of the research focuses on the role of social capital in building resilience. Yet, in general, this interlinkage seems to have received less attention from the scientific community than others in the nexus.

As in any nexus, harnessing synergies and addressing trade-offs is critical for policy-making. In this regard, contributing experts have noted that reducing inequalities in any of its dimensions also contributes to better infrastructure provision and increased resilience by, for example, increasing the likelihood of infrastructure investment that benefit vulnerable groups. In relation to infrastructure policies, a focus on both efficiency and equity is needed to harness the synergies in the nexus. An important policy component is geographic equity in the provision of basic services infrastructure. In order to increase synergies between infrastructure and resilience, regulation and incentive mechanisms need to be in place to integrate disaster risk

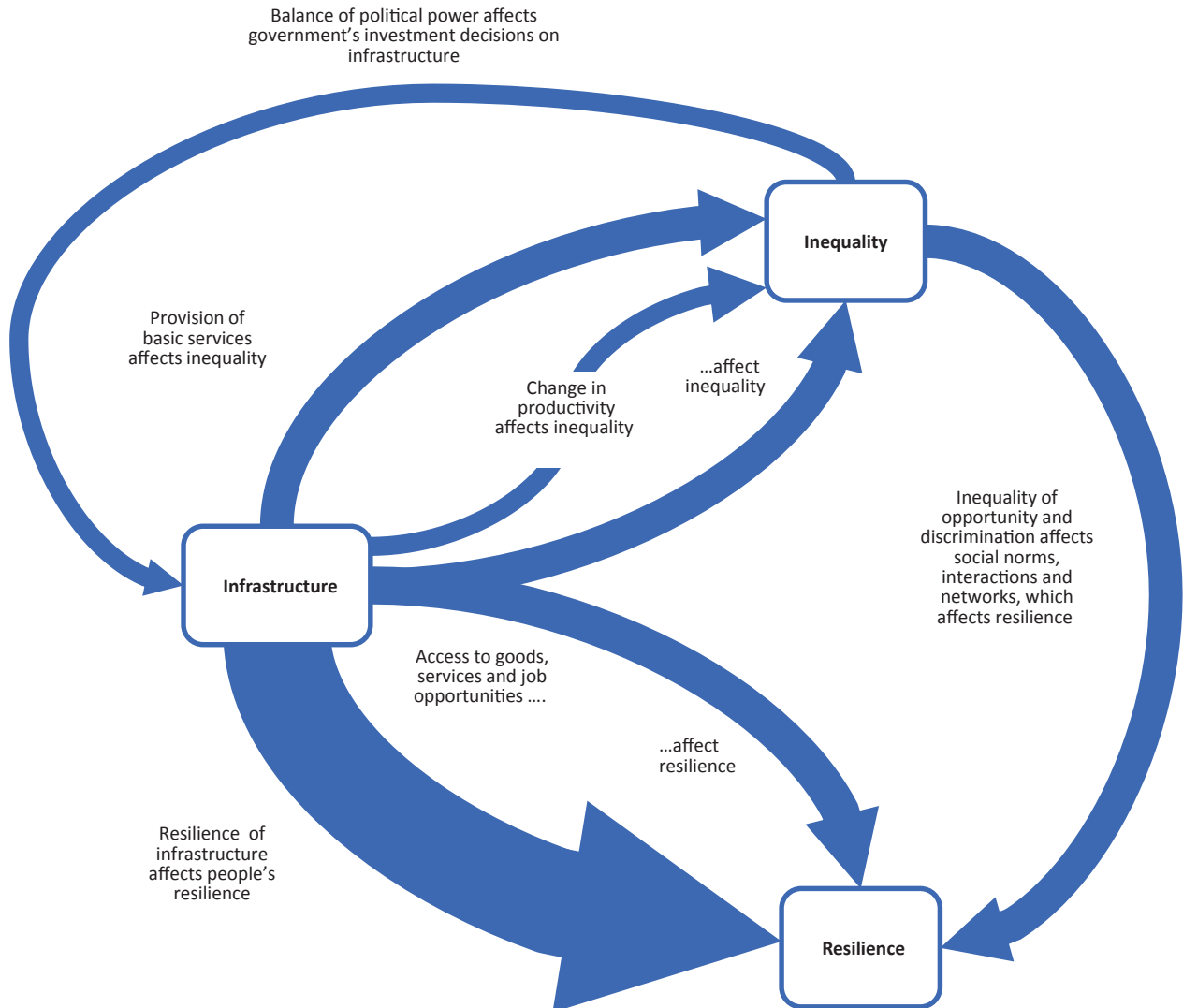
reduction into all phases of the infrastructure life cycle, and to ensure the resilience of critical infrastructure to natural disasters. It has been suggested that participatory processes that involve local communities and their various segments can be useful ways to ensure that considerations related to economic, social and environmental dimensions are taken into account when planning for infrastructure investment.

Contributing experts noted the need to further disaggregate the analysis between rural and urban contexts to be able to provide more specific policy recommendations. In rural areas, infrastructure investments are essential to connect individuals to livelihoods and opportunities. Urban areas provide easier connectivity, but tend to face challenges such as fragmented governance structures, congestion,

and high disparities in access to services, especially in informal settlements and peri-urban areas. The report provides examples of policies that have been found to address synergies in the nexus. For example, labour-based programs in infrastructure projects can expand job opportunities and reduce inequalities, while at the same time improving resilience to natural disasters.

Further cross-disciplinary collaboration and engagement between researchers, practitioners, decision-makers and other stakeholders could be a way of achieving the mutual learning and transfer of information that would enable scientific knowledge to be transformed into practical strategies to harness the synergies and address the trade-offs between the three areas of the nexus.

Figure 1: Evidence map of the infrastructure – inequality – resilience nexus



Source: Authors' elaboration based on inputs by experts and literature review.

Perspectives of scientists on technology and the SDGs

Chapter 3 of the GSDR presents a range of perspectives of scientists on the role of technology for the achievement of the SDGs. Understanding the role of technology for SDGs is critical because technology has greatly shaped society, economy and environment and vice versa. In fact, technology, society and institutions co-evolve. Hence, technology progress requires institutional adaptations and may be constrained by social issues. Policy actions to achieve the SDGs and ensure that no one is left behind need to consider these interlinkages.

Technology is essential for achieving the SDGs and reaping the benefits of synergies among them, as well as for minimizing trade-offs among goals. Shared appreciation of this importance of technology is reflected in its significant presence in the Sustainable Development Goals and targets. Indeed, technology is not only captured in SDG17 as a key means of implementation. Among the 169 targets, 14 targets explicitly refer to “technology” and many other targets relate to issues that are often largely discussed in technology terms. In general terms, the targets most closely related to technology fall in three categories: those that relate to significant overall technology performance improvement; targets for universal access to specific technologies; and targets that delineate elements of global effective innovation systems for sustainable development. The technology-related SDG targets are much less quantitative than corresponding targets proposed in the scientific literature.

While technology offers solutions to many sustainable development challenges, it has also continuously added new challenges. In particular, technology change can be a source of conflict or a tool for social inclusion and greater cooperation, and all technologies consume resources, and may use land and pollute air, water and the atmosphere, albeit to varying degrees. Examples of relatively new technologies considered in the report that illustrate this dual feature include digital automation, nanotechnology, biotechnology and genomics, and synthetic biology. These technologies are becoming driving forces for science, research and increasingly for economic activity. All hold great promises in terms of improving well-being and solving development challenges, but all of them present possible challenges.

For example, technology gaps exist in all sectors, and their nature and severity in terms of being a constraint to development differ greatly. New gaps often emerge with the application of new technologies, such as big data, the Internet of Things, 3D printing, massive online open courses and digital automation. All these could have wide-ranging implications that increase, rather than decrease, existing inequalities. While such technologies are in an embryonic

stage, it is important for countries to understand them, identify potential implications, and use foresight activities to guide policy planning exercises.

Chapter 3 provides an overview of perspectives of scientists on technology and the SDGs. It synthesizes contributions from 57 scientists and experts with research affiliations in 20 countries and representing more than forty sustainability science disciplines, who responded to two specific questions: What are the most promising actions or policy elements for optimal leveraging of technology for the SDGs and leaving no one behind? Which technologies and what level of their performance and deployment will be most crucial until 2030?

Many submissions from scientists received for the report point to a need for making simultaneous progress on equity issues (especially technology access), on overall technology system performance, and on supporting institutional change - strategies focusing only on one of these components have proven ineffective in the long-run. Policy actions must support both research and development to spur technology performance at the technology frontier, as well as promote the diffusion and adaptation of existing technologies in developing countries and among marginalized groups in all countries – one supports the other and vice versa.

What constitutes an effective technology policy differs between countries and depends on their levels of diversification and technological capabilities. Technology policy actions are most effective when they are firmly grounded in scientific knowledge and take into account the complexities of technology change, transfer and diffusion and the unique circumstances of the country in question. Innovation systems, understood as the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies, perform sub-optimally if only one or the other of these elements is supported. Policy actions must support both incremental, gradual technological and institutional improvements, as well as radical, Schumpeterian “gales of creative destruction”. Both are necessary – one requires the other. In this regard, education and infrastructure are essential pre-requisites for technology change.

In order for technology to support the realization of the SDGs, scientists who contributed to the report typically proposed policies and actions that encompassed not only one but several of the following areas: research, development and demonstration; technology transfer and diffusion; the establishment of goals, targets and mandates for specific technologies or technology systems (e.g., mandating a minimum share of renewable power generation); policy environment and market incentives; knowledge sharing and capacity building; and stakeholder participation and governance. They tended to highlight policies and actions

that are far beyond their own disciplinary expertise, which illustrates the relevance of integrated systems views for thinking of technology in the context of the 2030 Agenda.

Scientists emphasized a need for national and international action plans and technology roadmaps. Promising technological trajectories and new industries can be identified by each country. Scientists suggested the importance of investing at the same time in new and old technologies; in increased performance of advanced technologies and technology adaptations for underserved communities; in large-scale infrastructures and small-scale technologies with large numbers of units. They also suggested that science roadmaps should include measures relating to affordability and inclusion, which should be built into R&D processes from the outset. Other notable key actions or policy elements suggested by scientists include: effective national science-policy interfaces; foresight and scenarios; facilitation of learning across communities, including underserved communities; and cluster analysis. The latter analyses networks of firms linked to each other (through production chains, or geographically concentrated and making use of related buyers, suppliers, infrastructure and workforce, or of similar nature), with a view to addressing systemic imperfections of innovation systems.

Looking forward towards 2030, scientists identified crucial emerging technologies for the SDGs, which fall into the bio-tech, digital-tech, nano-tech, neuro-tech and green-tech categories. However, little information appears to exist on the level of performance and deployment of these technologies that would need to be achieved by 2030. While some quantifications exist in this regard, further collaboration on SDG scenarios and roadmaps that explicitly incorporate technology will be essential. Long-term technology roadmaps can support business development and policy planning.

Inclusive institutions: the example of national councils for sustainable development and parliaments

There is clear awareness that understanding institutions is important for delivering on the imperative to leave no one behind. Institutions are essential enablers of inclusiveness, even though not the sole ones. The 2030 Agenda does not prescribe institutional models for the national level, but outlines governance principles that institutions should strive to achieve, such as “effectiveness, inclusiveness, and accountability” (SDG 16), responsive, inclusive, participatory and representative decision-making at all levels” (target 16.7) and “policy coherence” (target 17.14).

Institutions can trigger behaviours and trends that can have positive or negative impacts for development outcomes, and in particular for inclusiveness. Inclusive institutions bestow equal rights and entitlements and enable equal opportunities, voice and access to resources and services.

They can be based on principles of universality (e.g. universal access to justice or services), non-discrimination (e.g. inheritance laws that protect widows' land rights), or targeted action (e.g. affirmative action to increase the proportion of women political representatives). On the other hand, power holders can shape institutions for the benefit of some rather than all groups of society. Institutions that are not inclusive potentially withhold rights and entitlements, can undermine equal opportunities, voice and access to resources and services and perpetuate economic disadvantage. They can also have a negative impact on non-economic dimensions of poverty, including lack of access to services, lack of voice in decision-making, and vulnerability to violence and corruption.

From a science-policy perspective, a natural question to ask is what types of institutions are necessary for achieving inclusive goals. Achieving any particular target will require a combination of factors, including: legal, regulatory components; multiple institutions intervening at various levels; and potentially broader societal changes, e.g. in social norms, which themselves can be spurred by changes in institutions. For example, the advancement of gender equality requires a range of actions at all these levels, and the intervention of a range of institutions with different mandates and purposes. Conversely, individual institutions, especially those with broad mandates, can contribute to inclusiveness in many different areas as well as society-wide. It is important to assess both how inclusive institutions are, and whether and how they foster inclusiveness through their actions. In this vein, the report explores two specific types of institutions: national councils for sustainable development (NCSDs) and national parliaments. More in-depth assessment of research is needed on other types of institutions and how they contribute to inclusiveness in the context of the new Agenda, and this should be a critical component of future GSDRs.

NCSDs were first identified as important institutional components in Agenda 21 in 1992. During the past two decades, many countries have experimented with versions of them, with various levels of success. Lessons learned from that phase can be useful for the implementation of the 2030 Agenda. Research reviewed for the report suggests that, if provided with adequate resources, NCSDs can be effective mechanisms for stakeholder participation and engagement across the whole policy cycle, to: (1) inform and educate the public at large on sustainable development related topics; (2) stimulate informed public debates; (3) engage key stakeholders in formulating policy recommendations; and (4) involve stakeholders in various parts of implementation and progress reviews. In practice, governments' attitude regarding stakeholder involvement influences the functioning of NCSDs and the resources provided to them. The composition of NCSDs usually

reflects the political system and culture in which they exist. In general, the more the NCS is dominated by the government, the more it tends to have communication of government policy to various stakeholders as its main role. The more independent the NCS, the more role it tends to play in the decision-making process.

As legislative bodies, parliaments are very important for the implementation of the 2030 Agenda and SDGs. Parliaments engagement is guided by each country's institutional regime and sovereign decisions. Parliaments approve laws and oversee their execution by the government; they also oversee national policies and strategic plans and approve budgets. In turn, governments are expected to report back to parliaments, which have at their disposal evaluations and assessments from bodies such as audit institutions. While countries differ in their parliamentary systems, all of them require parliamentary approval on legislation pertaining to the SDGs.

Chapter 4 of the report makes the distinction between inclusiveness of institutions, and inclusiveness through institutions. The former refers to whether institutions themselves are designed in a way that is conducive to inclusive representation and voice of all sections of society (or all countries). The latter refers to whether institutions, through their actions, directly support or enable more inclusive outcomes. In the case of parliaments, this means examining both how parliaments themselves are inclusive in their representation of all segments of society, including of marginalized groups, and how, when adopting legislation, they take into account the needs of these groups. For example, parliaments are in a unique position to enact legislation to contribute to the elimination of gender-based discriminatory norms and practices, foster women's participation in decision-making processes, and ensure equal access to resources, basic services, education, economic resources, land, and new technology, all of which are specifically highlighted in the targets of the SDGs.

In this regard, Chapter 4 looks specifically at women, indigenous peoples, persons with disabilities, and children and youth. Research reviewed for the report suggests that progress has been made with respect to the representation of these groups in national parliaments. However, gaps still exist. Similarly, while progress has been made in terms of codifying the rights of marginalized groups, there is still a long way to go in this respect, and parliaments will have a key role to play in ensuring that no one is left behind.

Identifying emerging issues for the HLPF

The identification of new and emerging issues warranting policy makers' attention is a critical function of the science-policy interface. Building on the 2014 and 2015 reports, this year's report provides an overview of existing approaches to identify emerging issues for sustainable development.

Policymakers are exposed to a broad range of analyses, rankings, and advice concerning emerging issues; consequently a categorization of existing material, informed by a sustainable development perspective, could contribute to improved policymaking. The process of identifying emerging issues can be usefully guided by criteria during the "scanning" phase of issues across a range of sources. Criteria can help to make explicit what counts as emerging issues. Impact and probability are common starting points. Additionally, criteria such as persistence, irreversibility, ubiquity, novelty, and potential for mobilization could also be considered. Priority, a criterion that is meant to capture an issue's importance in terms of social and cultural norms or impact on already vulnerable and marginalized groups, can accommodate principles such as "ensuring that no one is left behind".

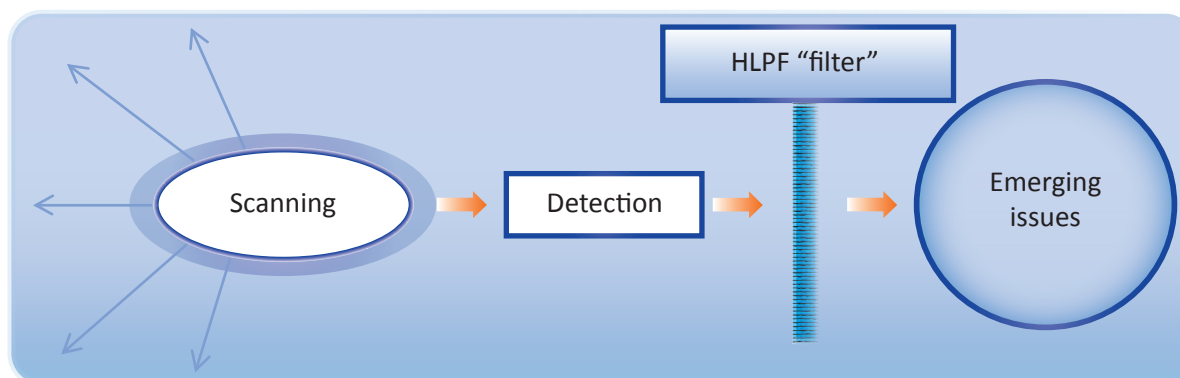
The report presents a sample of emerging issues from a variety of sources, such as global UN initiatives and national academies of sciences. The latter coordinate and define research priorities in all scientific fields of interest and importance to the particular country. Leading academic journals are an important source for the emerging issues as well, as they contain peer-reviewed academic contributions.

Additionally, a crowdsourcing initiative collected short science-policy briefs from scientists and researchers around the world, highlighting a specific issue, finding, or research with a bearing on sustainable development policy. The open call for this year's report resulted in 62 accepted briefs from all regions, following 202 briefs accepted in 2014 and 2015. The science briefs received since 2014 cover all the SDGs and address many of the linkages among them.

Even a guided scanning process for emerging issues is likely to generate a large number of issues. Some form of clustering or categorization of issues is necessary to facilitate analysis. Several commonly used frameworks were considered for this report. Largely due to its simplicity, the STEEP (Social, Technological, Economic, Environmental and Political) framework proved to be more suitable than others in enabling an initial categorization of a broad-ranging list of sustainable development issues. However, expert input highlighted the usefulness of taking an additional step to differentiate between issues that relate to values, threats, opportunities, causal mechanisms and responses.

While a set of issues may satisfy a number of criteria, a function of the science-policy interface consists of a second step: identifying a smaller subset of issues that are policy relevant. In the context of the HLPF, this entails identifying emerging issues that are appropriate for policymakers at the global level, by filtering out issues of primarily local or national significance. Naturally there are no neat, clear divides; what is local today can escalate across borders tomorrow. There is scope for enhanced dialogue between

Figure 2: Schematic representation for identifying emerging issues for the HLPF



Source: Authors' elaboration.

scientists and policy-makers at the HLPF in two areas. One is the process by which a large number of issues are filtered to produce a smaller list for consideration by the HLPF. The second are the substantive contours of the issues that the high-level political forum could consider.

Work done for the report included an attempt to operationalize such a filtering process on a pilot basis, actually going through the steps of producing a short list of issues that the HLPF could consider. This was done through a multi-disciplinary consultation of experts with knowledge and experience of various processes of identification of emerging issues. The exercise involved an initial list of issues, drawn up based on an online survey, which was discussed by experts in a face-to-face meeting. The top-ranking twenty issues resulting from a collective prioritization by scientists cover a broad range of areas (see Box 1).

The report demonstrates that a wide range of sources – document analysis, crowdsourcing, and expert meetings – can usefully be drawn on when identifying emerging issues in the context of sustainable development. The involvement of experts provided a valuable contribution to the discussion in not only in building a list of emerging issues, but in contextualizing the process of issue identification.

The report confirms once again the complexity and inter-disciplinarity of sustainable development issues, which involve complex relationships between economic, social and environmental dimensions. Scientific expertise can shed new light on the complexity and interconnectivity of emerging issues, in the process strengthening the science-policy interface and possibly leading to more timely responses to emerging threats or the exploitation of new opportunities.

Taking stock from three editions of the Global Sustainable Development Report

Since UN Member States foresaw a Global Sustainable Development Report as an instrument to strengthen the science policy interface for sustainable development at Rio+20, the report has become a platform and process for engaging scientists and experts in the UN deliberations on sustainable development. It has been open for participation to all interested UN entities, organized science institutions and programmes, and individual scientists – the only requirement being that contributions needed to be grounded in science. To date, 35 UN entities and more than one thousand scientists have contributed to the Report. The open call for science-policy briefs alone resulted in 589 scientists from all parts of the world submitting 264 briefs. The International Council for Science (ICSU) has played a crucial role in encouraging scientific contributions.

Taken together, the three reports published so far have contributed to the science-policy interface in two main ways. Firstly, they have provided specific suggestions on how the HLPF could operationalize the science-policy interface in practice in years to come. Chapter 1 of the 2015 edition suggested a range of ways for the HLPF to enable constructive interactions between science and policy-making at the UN. Actions that the HLPF might consider spanned the space between science and policy, from the provision of policy-relevant data, analysis and information, to actions that the HLPF could take to support enhanced dialogue between science and policy, to the translation of the results of science-policy dialogue into policy-making. All three editions devoted space to the identification of new and emerging issues, from their identification by all areas of science to how existing scanning processes may be combined to provide the HLPF with a usable list of topics for addressing in that forum.

Box 1. Emerging issues from a multi-disciplinary expert prioritization exercise

- Establishing governance mechanisms for the SDGs, from global (UN) to regional, national, and local levels.
- Coping with the increasing impacts of climate changes.
- Political instability and social unrest from increased income and wealth inequalities.
- Ensuring access to affordable, sustainable, and reliable modern energy services for all, and
- Accelerating the implementation of environmentally-friendly renewable energy.
- The need to develop alternative economic models that decouple economic growth resource use and minimize environmental degradation.
- The need to protect and restore ecosystems.
- Persistence of poverty globally, including the poor in rich countries.
- Strengthen and enhance the means of implementation and global partnership for sustainable development.
- Highly unequal distribution of household wealth across and within nations.
- Enhancing social protection and environmental protection in developing countries as a means to decrease inequalities and combat environmental degradation and climate change.
- Integrated assessment of sustainable development pathways.
- Increasing the sustainability, inclusiveness, safety, and resilience of cities and human settlements.
- The depletion of ocean fish stocks and the exploitation of marine resources.
- Time lags of several decades between scientific findings and policy action.
- Migration and all forms of movement of people across borders due to changes in demographics, weather patterns, and other causes.
- Promotion of sustainable industrialization.
- Reduction of future agricultural yields due to climate change, especially in Africa.
- Inadequate funding for health systems, especially in developing countries.
- Putting in place the blend of governance forms and approaches required for the 2030 Agenda.

Secondly, the reports have explored different perspectives on the SDGs as an integrated and indivisible set of goals, and translated those in chapters that adopted a diversity of focuses and approaches. The 2014 edition provided templates for looking at progress made on sustainable development over the long term, as well as for synthesizing insights from sustainable development scenarios undertaken by leading institutions covering a wide range of thematic areas. This also included the examination of four nexuses of issues (climate, land, energy and water; oceans and livelihoods; industrialization and sustainable consumption and production; and infrastructure, inequality and resilience), as well as cross-cutting issues (disaster risk

reduction, innovative data and measurement approaches, technology). These contributions provide illustrations of how policy-relevant conclusions can be gleaned from scientific assessments.

As the Global Sustainable Development Report moves to a new phase after the HLPF 2016, these concrete contributions and the collaboration that has been built with more than one thousand scientists can provide, along with the experience from other science-policy interfaces, an interesting base on which to build an ambitious yet actionable multi-year report for the benefit of the HLPF.

Introduction

Major international conferences and summits in 2015 – on financing for development, sustainable development, and climate change – have defined a new sustainable development agenda for the next 15 years. At all levels, from global to local, eyes will now be turned on implementing this ambitious agenda. This is the context in which this year's Global Sustainable Development Report (GSDR) appears. Building upon the 2014 and 2015 reports, the current report responds to the mandate from the Rio+20 Conference to contribute to strengthening the science-policy interface for sustainable development in the context of the high-level political forum on sustainable development (HLPF).

Given the adoption of the 2030 Agenda for Sustainable Development with its sustainable development goals (SDGs), the report adopts the SDGs as its scope. True to its mandate, the report is designed as an assessment of assessments rather than seeking to pioneer new knowledge. It endeavours to present a range of scientific perspectives and to be policy-relevant but not policy-prescriptive. Like its predecessors, it continues to explore possible approaches and vantage points from which to examine the science-policy interface, as well as scientific approaches that can inform policies building upon integration and interlinkages across sustainable development goals, sectors, and issues.

The report was prepared specifically to inform the discussions at the high-level political forum on sustainable development in 2016. The theme chosen for the HLPF is 'ensuring that no one is left behind'. This theme is a recurring thread in the report.

The content of this report is based on the knowledge and expertise of 240 contributing scientists and many experts from more than 20 United Nations agencies. It aims to bring together information and cutting-edge knowledge from a wide range of sustainability science disciplines across all regions of the world. As with the previous reports, the preparatory process benefited from a wide range of forms for outreach, including open calls for inputs and science briefs, collaboration among United Nations agencies, expert group meetings, and targeted requests for inputs to scientists and experts from multiple disciplines.

Chapter 1 aims to provide a reference frame for exploring the implications of the principle of "leaving no one behind" for the operationalization of the SDGs from a science-policy perspective. The chapter showcases how those left behind are defined by different disciplines and development practitioners. It points to existing mechanisms for targeting and reviews of the effectiveness of development interventions in targeting and reaching those left behind, and briefly documents commonly used development strategies in different SDG areas and existing scientific

reviews of how closely aligned they are with the objective of leaving no one behind and with the aspiration to reach the furthest behind first.

Chapter 2 continues the focus on interlinkages of previous editions of the report. It examines interlinkages between infrastructure, inequality and resilience. Based on a consultation of scientists from different disciplines, it highlights important channels of interconnection among these areas and distils the results of scientific analyses of the synergies and trade-offs among them. The chapter aims to strengthen science-policy interface by showing policymakers how key interlinkages are analysed by the scientific community, while providing the scientific community with some key policy questions and highlighting areas that may need further research.

Chapter 3 provides an overview of perspectives of more than 50 scientists on technology and the sustainable development goals. It aims to showcase promising actions and policy elements for fully leveraging technology for the achievement of the SDGs, also paying attention to the imperative to leave no one behind. It provides an overview of a range of technologies that contributing scientists identified as the most crucial in the implementation of the SDGs from now to 2030.

Chapter 4 focuses on institutions as essential components and enablers of inclusive societies. As examples of institutions relevant to sustainable development that can foster inclusiveness, the chapter showcases National Councils for Sustainable Development and parliaments. The chapter looks at these institutions both in terms of how inclusive they are, and how important they are in supporting inclusive outcomes.

The HLPF is mandated to ensure appropriate consideration of new and emerging sustainable development challenges. **Chapter 5** provides an overview of existing approaches and processes to identify emerging issues for sustainable development. It introduces potential guiding criteria that could be used in future editions of this Report to scan, among a multitude of emerging issues identified by different processes, those that the HLPF could consider putting on its agenda. The chapter also presents the main insights from an expert consultation process whose aim was to test the methodology proposed for identification of emerging issues and examine how best these issues could be brought to the attention of policy-makers.

The main conclusions from the report are gathered in **Chapter 6**, which also provides a short recapitulation of key lessons learned from three editions of the Global Sustainable Development Report in terms of content addressed and involvement of scientific communities.

ENSURING THAT NO ONE IS LEFT BEHIND AND THE 2030 AGENDA

“4. As we embark on this great collective journey, we pledge that no one will be left behind. Recognizing that the dignity of the human person is fundamental, we wish to see the Goals and targets met for all nations and peoples and for all segments of society. And we will endeavour to reach the furthest behind first.” (emphasis added)

A/RES/70/1. Transforming our world: the 2030 Agenda for Sustainable Development. Resolution adopted by the General Assembly on 25 September 2015.

1.1 Introduction

This introductory chapter attempts to briefly frame the theme of 'ensuring that no one is left behind' in the context of the 2030 Agenda and the sustainable development goals (SDGs), from a science-policy perspective.

Ensuring that no one is left behind is at the core of the 2030 Agenda for Sustainable Development, and is a fundamental guiding principle for its implementation. The pledge that 'no one will be left behind' appears at the outset in the second paragraph of the preamble and in paragraph 4 of the 2030 Agenda. In those same paragraphs, the Agenda attributes to all countries and all stakeholders the responsibility to implement the agenda. It emphasizes that goals and targets should be met for all nations and peoples and for all segments of society; and highlights the endeavour to reach the furthest behind first. As such, the pledge to leave no one behind relates to the Agenda in its entirety.

Fifteen years from now, when the current and the next generations together assess the implementation of the 2030 Agenda, a key measure of success will be the extent to which it has allowed every single person to thrive, regardless of gender, race, age, religion, place of residence, or any other factor. The call to leave no one behind has been heeded – many organizations have already started to work on the implications of this principle for the delivery of the 2030 Agenda¹ and for their missions.²

'Ensuring that no one is left behind' encompasses multiple meanings. For some, it will mean focusing action on disadvantaged groups of society, for example, people living in poverty, women, indigenous people, youth, older people, persons with disabilities, migrants, or people in conflict and post-conflicts situations. Others will focus on reducing inequalities between countries, including focusing action on countries at the lowest stages of development or facing challenging circumstances. Still others would propose other views and definitions of who those left behind are. Views may also differ on how society can effectively provide opportunities to those left behind. By implication, how different people foresee the timing and sequencing of necessary actions to ensure that no one is left behind might also vary. This has direct implications for how the 2030 Agenda will be implemented.

At the conceptual and practical levels, four broad questions need to be addressed. First, who are those left behind? Second, why are they left behind? Third, what methods and mechanisms exist to reach and involve them? And fourth, what types of strategies and policies would be appropriate in order to leave no one behind? Empirical evidence from a broad range of scientific disciplines, in particular social sciences, can inform decision-making on these questions. It can also provide elements to assess how ambitious and challenging it will be to realize the commitment of leaving no one behind, by revealing to what extent strategies and policies that have been used in various SDG areas focused on this objective, and what their success has been in achieving it. Beyond the commitment to leave no one behind, the ambition to 'endeavour to reach the furthest behind first' is also a transformative aspect of the 2030 Agenda.³ Does this imply different implementation strategies than those commonly used in the past? Here also, scientific evidence can inform the debate.

The chapter examines the implications of 'ensuring that no one is left behind' for the implementation of the 2030 Agenda. It briefly discusses the connections between the commitment to leave no one behind and three related concepts that are prominent in the 2030 Agenda: poverty, inclusiveness and inequality. The chapter then reviews some of the concepts and methods used to identify those left behind, as well as some of the methods that are used to reach them in practice. Finally, the chapter highlights

examples of development strategies used in various areas of sustainable development and what empirical evidence can tell us about their effectiveness in leaving no one behind.

The chapter serves as an introduction to other chapters of the report and is not intended as a comprehensive overview of the literature on inclusiveness, equity, inequality, social inclusion, discrimination and other related topics, which would need considerable space.⁴ Similarly, the chapter does not attempt to answer the question of why some groups or countries are left behind. Obviously, answering this question is critical to devising appropriate policies and strategies. Lastly, detailed discussions of the policy implications of 'leaving no one behind' for specific areas of the SDGs are left for other chapters.

1.2 Leaving no one behind, poverty, inclusiveness and equality

The pledge to leave no one behind relates closely to three important dimensions of the 2030 Agenda: poverty, inclusiveness and inequality. Poverty in its various dimensions remains at the center of the New Agenda, as it used to be at the center of the Millennium Development Goals and was identified as one of the three overarching objectives of sustainable development.⁵ In the eyes of the lay person, poverty is an obvious way to identify those left behind. Poverty measures have also commonly been used to identify those left behind in development practice (see below).

The word 'inclusive' was used in the title of five of the Goals. It is also used in five of the targets, and 22 times in other parts of the 2030 Agenda. That emphasis suggests that, in the eyes of the negotiators who crafted the Agenda, it was a very important concept.⁶ Inclusiveness (social, economic, political and cultural) talks to the notion of empowerment and the principle of non-discrimination. It refers to the need to include everyone in societal processes, and conveys the notion that people should not only be allowed to thrive, but should have a voice and effective opportunities to shape the course of development. SDG 5, SDG 10, SDG 16, inter alia, have very strong connections to inclusiveness and empowerment. The cross-cutting commitment to disaggregate data to monitor the SDGs also reflects the notion of inclusiveness. One might argue that the prominence of this notion in the 2030 Agenda extends the concept of participation that was pioneered in Agenda 21.

The concept of equality – or inequality – is also prominent in the 2030 Agenda. It has a standalone goal, SDG 10, which aims to reduce inequalities within and among countries, and is also directly reflected in goals and targets across the Agenda, including in the goals for health, education, gender, and others.

Equality as a concept has traditionally been related to equality of outcomes and equality of opportunities. Inequality of outcomes can be found everywhere, as any variable with a distribution over a population (e.g., income or access to certain services) generates some form of inequality, which can be measured by different statistics. Inequality of opportunities refers to cases where different people or sections of society do not have the same opportunity to participate in society and to flourish. This can be the result of explicit and implicit barriers to certain sections of the population, such as discrimination in the law, in custom and in practice, which limit access to opportunities for certain groups in society. In addition, equality can also be seen in a political sense and related to empowerment. Equality in that sense relates to giving different people and sections of society equal voice and equal opportunities in political and social institutions, and more control over their lives.⁷

The different declinations of inequality are not mutually exclusive, as pointed out by many.⁸ All are relevant in relation to leaving no one behind. Different communities concerned with inequality and discrimination may put different emphasis on them. For example, in approaches focused on human rights, inequalities of outcomes in regard to specific rights will be a primary indicator for concern (e.g. the gender wage gap, school enrolment rates). Inequality of opportunities and discrimination would then be seen as the means through which unequal outcomes happen; and empowerment as one of the means to combat such discrimination and remedy inequalities of opportunities and outcomes. In the development literature, a strong tradition that underpinned development programmes worldwide focused on inequalities of outcomes and on increasing the number of “haves” or reducing the number of “have-nots”. For example, rural electrification programmes and programmes of universal access to drinking water and sanitation put emphasis on the number of connected households, in addition to affordability and quality of the services. Yet, development institutions are also interested in access to basic services as a necessary condition for achieving greater equality of opportunity. For example, access to quality education and clean drinking water is seen by development practitioners as a key to opportunities in terms of improved health and education outcomes, as well as higher productivity and income.⁹

1.3 Leaving on one behind in Sustainable Development Goals and targets

‘Leaving no one behind’ is not just an overarching imperative expressed in the 2030 Agenda. Many targets of the SDGs provide concrete objectives in direct relation with that aim; many targets also point to specific means through which it

can be achieved – providing concrete illustrations of how to ensure that no one is left behind.

Several targets relate to the international level, and aim to ‘leave no country behind’. Those focus on groups of countries traditionally identified in the United Nations, such as developing countries, least developed countries (LDCs), landlocked developing countries (LLDCs) and small island developing states (SIDS). Such targets cover a broad range of topics, from economic growth in LDCs to industrialization and participation in global trade, to broadening and strengthening the participation of developing countries in the institutions of global governance (Table 1-1).

In turn, many SDG targets detail supporting measures to achieve these objectives. Those include: measures related to official development assistance and other financial means; commitments to increase or support investment in specific sectors, with focus on developing countries, for example agriculture, medicines and infrastructure; international cooperation and technical assistance; actions on trade; promoting the rule of law at the international level; enhancing cooperation on and access to science, technology and innovation. In addition, many other SDG targets refer to groups of countries in special situations as deserving special attention.

At the national level, targets explicitly aiming at ‘leaving no one behind’ are multiple. Many targets aim to reduce inequalities of outcome. This includes: ensuring universal and equal access to basic services; ensuring access to food for all, and end malnutrition; achieving and sustaining income growth of the bottom 40 per cent of the population at a rate higher than the national average; and doubling agricultural productivity of small-scale food producers. Targets that detail measures in support of these objectives include: putting in place social protection systems and policies; building the resilience of the poor and vulnerable; access to employment; and expanding infrastructure with a focus on affordable and equitable access for all.

Other targets focus on ending discrimination. This includes: empowering and promoting the social, economic and political inclusion of all; ending all forms of discrimination against women and girls; eliminating violence against women and girls; ending abuse, exploitation, trafficking and all forms of violence against and torture of children; recognizing unpaid care and domestic work; equal access to technical, vocational and tertiary education; and equal pay for work of equal value. Targets that detail measures in support of these include: eliminating discriminatory laws, policies and practices and promoting and enforcing appropriate legislation, policies and action in this regard; promoting the rule of law and ensure equal access to justice for all; protecting fundamental freedoms; eradicating forced labour, including the worst forms of child labour, and

Table 1-1: Examples of targets in the SDGs that relate to leaving no country behind

Aspirational targets	Means to ensure that no country is left behind
<ul style="list-style-type: none"> • Reduce inequality between countries (10) • GDP growth target for least developed countries (8.1) • Promote inclusive and sustainable industrialization with a focus on least developed countries (9.2) • Broaden and strengthen the participation of developing countries in the institutions of global governance (10.6, 16.8) • Promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed (2.5) • Increase the economic benefits to SIDS and LDCs from the sustainable use of marine resources (14.7) • Significantly increase the exports of developing countries (17.11) 	<ul style="list-style-type: none"> • Encourage official development assistance and financial flows, including foreign direct investment, to States where the need is greatest (10.b) • Provide adequate and predictable means for developing countries, in particular LDCs, to implement programmes and policies to end poverty in all its dimensions (1.a) • Increase investment in agriculture in developing countries (2.a) • Correct and prevent trade restrictions and distortions in world agricultural market (2.b) • Support the research and development of vaccines and medicines for ... diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines (3.b) • Scholarships for developing countries (4.b) • International cooperation for teacher training (4.c) • Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support (9.a) • Increase Aid for Trade support for developing countries (8.a) • Implement the principle of special and differential treatment for developing countries (10.a) • Implementation of duty-free and quota-free market access for LDCs (17.12) • Promote the rule of law at the international level (16.3) • Enhance cooperation on and access to science, technology and innovation (17.6) • Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries (17.7) • Support developing countries in strengthening the capacity of national statistical offices and data systems (17.18)

Source: Authors' elaboration.

Note: Target number in parenthesis.

Box 1-1: Gender equality, vulnerability and climate change in the science-policy briefs submitted for the GSDR 2016

Gender discrimination persistently affects every aspect of development in many countries. While the need for gender equality and women's empowerment is not an emerging issue, there appears to be a growing understanding within various scientific disciplines that in order to promote equality and improve women's rights, complex underlying social norms must be examined and challenged.

Research from numerous countries in Africa, Asia and Latin America shows that gender relations, roles and perceptions are rapidly shifting at the local level as a result of adaptation to impacts from environmental degradation and climate change. Yet too often, policies intended to address gender do not explicitly discuss men's activities and contributions (or the absence thereof), and focus only on participation by women, without examining the underlying social and cultural dimensions of gender that are critical for enabling women's equality and empowerment.^{10, 11}

To understand vulnerabilities and capacities and inform effective and responsive adaptation planning, assessments of climate change vulnerability and impacts should examine the ways in which gender intersects with other pertinent factors, such as ethnicity, economic assets and social status.¹² Indeed, equitable policy making in general must strive to identify those most vulnerable based on a range of socio-demographic variables including gender, class, education, access to assets.

Source: science-policy briefs submitted for the GSDR 2016.

human trafficking; protecting labour rights; and providing legal identity for all, including birth registration.

Lastly, many targets relate to opportunities, empowerment and enhancing capabilities. This is the case of targets related to universal primary and secondary education, literacy and numeracy; ensuring women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life; ensuring responsive, inclusive, participatory and representative decision-making; universal access to sexual and reproductive health and reproductive rights; full and productive employment and decent work; and increase in skills for employment and entrepreneurship. Targets that detail measures in support of these include: ensuring equal access to economic resources; provision of public services and infrastructure; enhancing access to markets and financial services for households and SMEs; policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation; fiscal, wage policies aiming to progressively achieve greater equality; use of enabling technology, in particular information and communications technology; access to sexual and reproductive health-care services; promotion of shared responsibility within the household and the family; participatory planning and resource management; and public access to information.¹³

In addition, many SDG targets specify segments of the population that deserve special attention. For example, target 11.3 on sustainable transport specifies "with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons".

1.4 Who are those left behind?

1.4.1 Defining and identifying those left behind

In order to make the imperative to leave no one behind a reality on the ground, the first question to address is who those left behind are. This question can itself be

decomposed into sub-questions, reflecting the importance of the spatial and temporal dimensions in development. A first sub-question is who are those left behind now, and who could they be in the future? A second sub-question is, where do those left behind live? The former is critical to reflect the dynamic nature of poverty, inequality and deprivation (see 1.4.2 below) and the fact that the Agenda will span the next fourteen years. It also reflects the dimension of intergenerational equity.¹⁴ The latter is critical in order to address the problem on the ground, as those left behind may be different subsets of the population in different places (e.g. in urban areas versus rural areas). In addition, most if not all development interventions – from investment in schools to water and electricity infrastructure to access to finance – have an inherent spatial component to them.

As discussed above, one of the ways to identify those left behind that has been widely used in the development discourse and practice has been to focus on poverty, and especially on income poverty.¹⁵

In recent decades, the notions of multi-dimensional poverty and multiple deprivations have gained traction both at the conceptual and practical levels, and are frequently used to identify people, groups or communities left behind. Both concepts respond to the need for more comprehensive ways to identify those left behind in society, beyond poverty income measures. Since 2010, the United Nations Development Program (UNDP) has published the Multidimensional Poverty Index (MPI), replacing the Human Poverty Index popular since 1997. The MPI incorporates ten weighted indicators that measure education, health and standard of living.¹⁶ Other examples include: the Better Life index produced by the OECD¹⁷; the Social Progress Index produced by Social Progress Imperative¹⁸; and the Human Opportunity Index (HOI), which was used for measuring inequality of access to infrastructure across time in Latin America.¹⁹ Such composite indexes have been used to better understand the factors that affect well-being and deprivation.

A methodological caveat that applies to composite indexes in general relates to the multi-dimensionality of concepts

Box 1-2: Evolution of income poverty during the MDG period

The incidence of income poverty has considerably declined over the past couple of decades. Among emerging and developing economies, in 2012 – the latest year with available data – the share of those in extreme poverty was just under 15 per cent of the total world population (excluding advanced economies). Projections indicate that the global extreme poverty rate has fallen further, to 12 per cent, as of 2015. This is down significantly from 47 per cent in 1990 and 25 per cent in 2005. Countries in Asia and the Pacific, notably China and India, have been particularly effective in reducing poverty over the last couple of decades. Progress among African countries has been less pronounced, as 41 per cent of the population in sub-Saharan Africa still live in extreme poverty. In Western Asia, the extreme poverty rate is expected to increase between 2011 and 2015.

Source: The Millennium Development Goals Report 2015, United Nations, New York, 2015.

such as poverty and deprivation, which by extension applies to concepts such as “those left behind” and “the furthest behind”. If there is more than one relevant dimension, it becomes a matter of convention or value judgment to define who is “behind”. In addition, some indicators of well-being or deprivation may not be considered so by some groups of communities with different sets of values.²⁰ However, from a normative side, there is generally broad agreement that people (or households) who do not have access to certain rights, goods or services are “left behind”.²¹ Such sets of “must haves” and the corresponding thresholds defining deprivation are often enshrined in national law and practice. Many of them are also inscribed in international law and standards.²²

In practice, those “left behind” may be different groups in different societies. For example, when considering nutrition, many countries still face stunting as the most pressing challenge; in other countries, obesity and its consequences in relation to health, mobility, and well-being, is more significant. Similarly, in education, future challenges in developed countries seem different from what they were a few decades ago. A recent OECD study shows that girls outperform boys in reading in almost all of the study countries. This gender gap is particularly large in some high-performing countries, where almost all underperformance in reading is seen only among boys, demanding special strategies to address this gap.²³

Statistics and data are increasingly available on individual indicators of deprivation, even if data availability remains a major challenge. This is reflected in the proliferation of tools, instruments and processes that monitor outcomes in specific areas of sustainable development.²⁴ In addition, research has also focused on examining the intersection between specific dimensions of deprivation and other SDG areas.²⁵

However, for operationalizing the notion of those left behind or furthest behind, it is often the combination of deprivations, in a spatial context, which matters. Advances in the conceptualization of poverty, inequality and exclusion as multidimensional phenomena, coupled with fast

progress in geographic information systems over the past decades, have extended the realm of spatial analysis of poverty. In particular, it has resulted in rapid growth in the availability of so-called “multiple deprivation maps”, which combine social, economic and environmental deprivation indicators. Such maps are published by both Governments and non-government actors. In both developed and developing countries, they have been used as an instrument for planning and management at different geographical levels, from national to sub-national to municipality level to local down to the housing block level.²⁶ Yet, data availability remains a critical issue. As highlighted in Agenda 2030, critical data gaps remain with respect to monitoring the SDGs, and this is more acute in developing countries.²⁷

1.4.2 Dynamic versus static measures of inequality and poverty

Because of the way they tend to be presented, many images of poverty and inequality, for example “the bottom billion”, “those furthest behind”, are easily interpreted in static terms, implicitly conveying the idea of stable and clearly identifiable groups within a population. This is reinforced by the fact that the poverty headcount ratio is the most common measure of poverty, and poverty is most widely measured as a stock.^{28, 29}

However, inequality and poverty are intrinsically dynamic. Individuals or households move across the income distribution and from one category to another, making the groups of the population at risk of poverty bigger than the stock of poor at any point in time. Shocks of various natures affecting households (e.g. health, employment, food prices, natural disasters) cause them to move in and out of poverty. In some countries, temporary spells below the poverty line are experienced by a broad cross-section of society.³⁰

Therefore, static analyses are not sufficient to address inequality and poverty.³¹ Exposure to poverty and other types of deprivation and capacity to exit poverty depend not only on the nature of shocks affecting individuals or households, but also on the initial position of households in terms of

Box 1-3: The Small Area Index of Multiple Deprivation in South Africa

The Small Area Index of Multiple Deprivation 2011 is the latest in a series of indices of multiple deprivation for South and Southern Africa that have been developed using census data to describe multiple deprivation at sub municipality level. The original South African study for 2001 was at ward level and was followed by a series of further refinements to develop a very small area or datazone level index for a series of child focused indices and updates to 2007 at municipality level. Indices have also been produced for Namibia. The ward and datazone level indices have been used in many ways by national and provincial government, including targeting areas for the take-up of child support grant, prioritising wards for specific antipoverty interventions and in the case of the City of Johannesburg, as part of the mechanism to target its indigence policy. Specific reports utilising the indices have been developed for various provinces and for the city of Johannesburg.

Source: Noble, M., Zembe, W., Wright, G., Avenell, D., (2013) Multiple Deprivation and Income Poverty at Small Area Level in South Africa in 2011 Cape Town: SASPRI.

Box 1-4: Disaggregation in the SDG Global Indicator Framework

The concept of “no one left behind” implies that the agenda’s Goals and targets should be met for all nations and people and for all segments of society. Ensuring that this commitment is translated into effective action requires data and analysis on the status of all groups of the population, including the most vulnerable and difficult to reach. However, the disaggregated data needed to address all groups – including children, youth, persons with disabilities, people living with HIV, older persons, indigenous peoples, refugees, internally displaced persons and migrants – as specified in the 2030 Agenda, are sparse. In the context of the SDG global indicator framework, the Inter-agency and Expert Group on SDG Indicators has recommended that all indicators referring to targets that explicitly mention particular groups of the population should be disaggregated for those groups. Moreover, SDG indicators will need to be disaggregated in a way that highlights the challenges of the most vulnerable populations and provide an understanding of progress and implementation in sub-national and local contexts, to ensure that no one is left behind. The list of global SDG indicators agreed by the UN Statistical Commission in March 2016 contains an overarching principle that requires that “Sustainable Development Goal indicators should be disaggregated, where relevant, by income, sex, age, race, ethnicity, migratory status, disability and geographic location, or other characteristics, in accordance with the Fundamental Principles of Official Statistics”.

Aggregated statistics often mask the situation for specific vulnerable groups. For example, while over 90 per cent of births in urban areas are attended by skilled health personnel, the share is only 72 per cent for rural areas. Children from the poorest households are nearly four times more likely to be out of school than their counterparts from the richest households. Work to identify data sources and recommend improvements in data collection and integration of innovative data sources is underway. Substantive experts who are familiar with the challenges in achieving specific SDG targets are involved in identifying the demand for disaggregated data, and data producers are working to identify ways to expand data availability, analysis and utilization to address all groups and geographical locations. The current proposed work stream of the IAEG-SDGs on data disaggregation will provide the overall direction for the work to be undertaken by the national and international statistical systems, including by promoting a dialogue between data producers and data users on data disaggregation needs and data and policy needs.

For some countries, there are also political and/or legal concerns in providing disaggregated data at the individual level in terms of confidentiality, privacy and safety of the respondents. For example, some countries legally prohibit the collection of information on race and religion, or sexual orientation, among other characteristics.

Source: UN Secretary-General’s Report on SDGs, Report of the IAEG-SDGs to the 47th Session of the UNSC, and contribution from UNEP to the GSDR 2016.

endowments (assets and income) and entitlements (access to goods; access to protection). Therefore, instruments to protect against shocks, as well as instruments to improve the circumstances of households such as opportunities for employment, are both required, as are instruments to support permanent exits from poverty and address inequality.³² The necessity to consider differentiated policies according to the transitory or permanent nature of deprivations faced by individuals and households has long been recognized in many fields. For example, policies aiming to address unemployment have long distinguished long-term unemployment from more transitory spells, and Governments have put in place different instruments in this regard.³³

As mentioned above, the temporal dimension is also intrinsically important, as the concept of sustainable development fully integrates the needs and well-being of future generations. In this context, understanding how current strategies, policies and actions are likely to impact future generations is critical.³⁴

1.4.3 Reaching those left behind

Beyond identifying those left behind, reaching them through delivery mechanisms (such as social services, basic

services, training programmes, etc.) necessitates general administrative and institutional will and capacity, trained personnel (e.g. community workers, social workers) as well as specific administration, management and accountability systems. Targeting has often been used in order to reach specific groups of the population.

Targeting methods can be broadly categorized into: direct individual/household assessment by an official or a group of community members; targeting based on a specified category such as age group or region; and self-selection targeting for programmes that are universal but are designed in a way to encourage the target categories to use the programme and discourage others to do so. All methods have advantages and drawbacks (see Table 1.2). Usually, interventions use two or more methods of targeting combined. Poor countries tend to use more self-selection and categorical targeting methods while less poor countries use relatively more individual assessments.

The costs of targeting are associated to the costs of collecting the information to identify the targeted group, which are expected to increase with the precision of the targeting; private costs of the beneficiaries, for example transportation costs; incentive costs that may induce people to change their behaviour to become part of the

targeted group; the social costs of identifying households as poor, which may cause social stigma; and political costs of excluding others from the programme, such as the middle class.³⁵

In 2004, a comprehensive review of 122 case studies drawn from 48 countries and published in academic journals in the period from 1990 to 2002 assessed the effectiveness of mechanisms used to target the poorest and most vulnerable in interventions that included cash, near-cash

and food transfers, food and non-food subsidies, public works for job creation and social funds. The study found that different targeting methods showed a range of results in terms of effectiveness in reaching the target groups.³⁶ Another comprehensive review done by the World Bank in 2005 for electricity and water subsidies found that most of the existing subsidies at the time were regressive, as the combined effects of lower connection rates, lower take-up given access, and lower consumption in the poorest groups meant that the bulk of subsidies was reaching high and middle-income groups.³⁷

Table 1-2: Typology of existing methods to target those left behind

	Description	Advantages	Limitations	Appropriate circumstances
Individual/household assessment				
Means testing	Direct assessment of the eligibility of the individual or household	<ul style="list-style-type: none"> Potentially very accurate 	<ul style="list-style-type: none"> Requires high levels of literacy and documentation Administratively demanding May induce work disincentives 	<ul style="list-style-type: none"> High administrative capacity Level of benefits justify administrative costs
Proxy means tests	Easily observed characteristics are used to give a score to households, which is compared to a cut-off to determine eligibility	<ul style="list-style-type: none"> Verifiable Less likely than means test to affect work effort 	<ul style="list-style-type: none"> May seem arbitrary Requires literate and computer-trained staff May be inaccurate at household level Insensitive to fast changes in welfare 	<ul style="list-style-type: none"> Reasonably high administrative capacity Stable situations Larger programme to maximize return for fixed overhead
Community targeting	Independent community members decide who in the community should receive benefits	<ul style="list-style-type: none"> Local knowledge Local definition of need and welfare 	<ul style="list-style-type: none"> Local actors may have other incentives besides good targeting May lower community authority or cohesion May perpetuate patterns of social exclusion Local definition of welfare may make evaluation more difficult 	<ul style="list-style-type: none"> Local communities are clearly defined and cohesive For programmes that include a small portion of the population Temporary and low benefit programmes
Categorical targeting				
Geographical targeting	Eligibility determined by the location of residency	<ul style="list-style-type: none"> Simple No labour disincentive Unlikely to create stigma Easy to combine with other methods 	<ul style="list-style-type: none"> Depend on accuracy of information Performs poorly where intended beneficiaries are not spatially concentrated Can be politically controversial 	<ul style="list-style-type: none"> Considerable spatial variation Limited administrative capacity Delivery of intervention use a fixed site such as school or clinic
Demographic targeting	Eligibility determined by age, gender or some other demographic characteristic	<ul style="list-style-type: none"> Simple Often politically popular Low stigma 	<ul style="list-style-type: none"> Inaccurate where demographic characteristics poorly correlates with those left behind 	<ul style="list-style-type: none"> Good register of demographic characteristics Low-cost targeting method required
Self-targeting				
	Intervention is open to all but it is designed in a way that take-up for it will be much higher among the intended target group	<ul style="list-style-type: none"> Administrative cost likely low Unlike to induce labour disincentives 	<ul style="list-style-type: none"> May impose costs on the recipients Stigma may be considerable May be difficult to deliver large benefit 	<ul style="list-style-type: none"> Low administrative capacity People move rapidly in and out target group Behaviour separates intended from non-intended beneficiaries

Source: Authors' elaboration, based on Coady et al. (2004) and Komives et al. (2005).

1.5 Strategies for ensuring that no one is left behind

Leaving no one behind will require, above all, understanding and addressing the root causes of poverty, inequality, and marginalization.³⁸ As detailed in chapter 4, strategies to leave no one behind will require a combination of factors, including: legal, regulatory components; multiple institutions intervening at various levels; and potentially broader societal changes, e.g. in social norms. In particular, the principle of 'leaving no one behind' can also have legal implications.³⁹

While leaving no one behind is a cross-cutting dimension of the new Agenda, ultimately, reaching those left behind will require specific strategies, whose nature may differ across SDG areas. Some areas may lend themselves more easily to strategies that focus on leaving no one behind as a core objective. Empirical evidence from past decades can inform on how concerns relating to inclusiveness can be reflected in various strategies, and how existing strategies have performed in this regard.

1.5.1 Economy-wide growth strategies.

In the context of macro-economic (economy-wide) growth strategies, poverty is often used as a proxy measure for those left behind. As a result, a large volume of economic literature has focused on the impacts of economic growth on poverty. Debates among development practitioners on how to achieve poverty eradication most efficiently have existed for decades.⁴⁰ While economic growth is generally seen as a necessary ingredient for poverty eradication, the precise channels through which growth translates into poverty reduction, as well as the role that States, policies and institutions can play in these mechanisms, have remained fiercely contested.^{41, 42, 43}

In terms of strategies for reducing income poverty, it was popular at the end of the 20th century to contrast macroeconomic pursuit of growth to increase the average income of the population and so called "pro-poor" growth strategies, which in addition to general growth also aim for relatively faster growth of incomes of poorer households. While the latter seem to embed the notion of leaving no one behind, a concrete challenge is highlighted in the literature in terms of how to identify when a strategy is really pro-poor, or how to identify strategies that are "more pro-poor" than others. Different indicators could be used and may provide different answers.⁴⁴ In addition, since the beginning of the 2000s, a general consensus has developed that inequality can negatively affect growth.

There has been considerable debate regarding the effectiveness of different strategies. One part of the literature has interpreted the empirical evidence as showing that, in the medium- to long-run, most of the

variation in changes in poverty in a sample of developing countries during the 1980s and 1990s can be attributed to growth in average incomes rather than poverty-reducing pattern of growth in relative incomes, suggesting that broad-based growth policies should be central to the pro-poor growth agenda.⁴⁵ Others have pointed that analysis of the effectiveness of poverty reduction strategies should be mindful of the differences in underlying structural economic dynamics, not only across broad economic sectors (i.e. agriculture, industry and services) but also within them⁴⁶, and of differences in integration of economies within global markets.⁴⁷ Lastly, the success of China in reducing poverty during the past decades has highlighted the importance of the State beyond its minimal Washington consensus role of providing an "enabling environment", including in that case important efforts to invest in education and conducting reforms that provided broad access to assets such as land, and implementing a long-term forward-looking industrial policy with a view to advancing industrialization and structural transformation.^{48, 49}

A key element for reaching the furthest behind is promoting the shift of labour from low- to high-productivity and high-wage activities.⁵⁰ Others emphasise the importance of broad-based economic growth that is conducive to the generation of decent jobs and stimulates the transition from informal economies to formal economy and employment, with a focus on small and medium enterprises.⁵¹ People's living standards depend on how they make a living. Hence, the importance of agriculture for rural poor and of manufacturing for urban poor⁵², and the need for strategies to eradicate poverty to be mindful that the lives and livelihoods of rural households in least developed and developing countries are becoming gradually dissociated from agriculture as non-farm opportunities have expanded.⁵³

1.5.2 Social protection systems⁵⁴

Social protection systems are a fundamental component of the way societies manage to leave no one behind. In the most general sense, the idea of social protection "... captures how members in societies support each other in times of distress".⁵⁵ This includes in particular social insurance systems, defined as contributory funds that people can draw from under specific, pre-defined circumstances, such as exclusion from the workforce due to unemployment (unemployment benefits) and old age (pensions); and social assistance measures, defined as transfers provided to different groups of households or individuals in relation to specific circumstances such as having children (child benefits, maternity coverage) and disability (disability allowances).

The majority of the people living in developing countries have weak and incomplete government provided social protection systems. The International Labor Organization

reports that only 27 per cent of the global population have access to comprehensive social security systems, whereas 73 per cent are covered partially or not at all.

Despite a large expansion of schemes, existing social protection policies do not sufficiently address the income security needs of children and families, particularly in low- and middle-income countries with large child populations. Specific child and family benefit programmes rooted in legislation exist in 108 countries, yet often cover only small groups of the population. In 75 countries, no such programmes are available at all.⁵⁶ Worldwide, less than 40 per cent of women in employment are covered by law under mandatory maternity cash benefit schemes; 57 per cent if voluntary coverage (mainly for women in self-employment) is included. Due to ineffective enforcement and implementation of the law in some regions, effective coverage is even lower. An increasing number of countries are using non-contributory maternity cash benefits as a means to improve income security and access to maternal and child health care for pregnant women and new mothers, particularly for women living in poverty. However, significant gaps remain.⁵⁷

In many countries with high shares of informal employment, pensions are accessible only to a minority. Under existing laws and regulations, only 42 per cent of people of working age today can expect to receive contributory or non-contributory social security pensions from contributory schemes in the future, and effective coverage is likely to be even lower. Many countries have recently made efforts to expand the coverage of contributory pension schemes and to establish non-contributory pensions to guarantee at least basic income security guarantee in old age to all. With rapid ageing of the population in many countries, pension systems will face considerable pressure in the future.

More than 90 per cent of the population living in low-income countries remains without any right to coverage

in health. Despite coverage, health care is frequently neither available nor affordable, and access to needed services can lead to poverty. Often, even people who are legally covered experience limited health benefits, high out-of-pocket payments and a lack of the health workers needed to deliver services, or cannot access services due to discrimination. Recently, the UN General Assembly requested ILO, along with WHO and other UN agencies, to give high priority to working jointly towards universal health coverage, and towards the associated goal of establishing social protection floors. In developed countries, according to the OECD, health care quality is not able to keep pace with the demands resulting from ageing population and the growing number of people suffering from one or more chronic diseases.⁵⁸

1.5.3 Area-based strategies

The idea that development strategies should be integrated (i.e. combining a range of actions in different sectors) and focus on well-defined geographical areas has a long history in development practice, from integrated rural development projects in the 1970s⁵⁹, to the Millennium Villages Project, to slum upgrading and urban rehabilitation programmes. At the basis for such interventions is the recognition that the place where people live is often an overwhelming determinant of the outcomes they achieve and opportunities they are offered, in areas as diverse as access to shelter and basic services, access to education, health, transport, and jobs. Strategies used in this context tend to emphasize a comprehensive range of intervention, covering sectors as diverse as shelter, water and sanitation, electricity, infrastructure, and in the case of rural programmes agriculture and land management. The success of these interventions has been very variable^{60, 61}. For example, in slum upgrading programmes across the world, it has been a recurrent feature that programmes tended to focus on physical aspects, while not necessarily taking proper account of economic and social aspects, for

Box 1-5: Selected recent figures on the reach of social protection systems:

- Only 27 per cent of the global population enjoy access to comprehensive social security systems, whereas 73 per cent are covered partially or not at all.
- Worldwide, 2.3 per cent of GDP is allocated to public social protection expenditure ensuring income security during working age; regionally, levels vary widely, ranging from 0.5 per cent in Africa to 5.9 per cent in Western Europe.
- On average, governments allocate 0.4 per cent of GDP to child and family benefits, ranging from 2.2 per cent in Western Europe to 0.2 per cent in Africa, and in Asia and the Pacific.
- 48 per cent of all people over pensionable age do not receive a pension.
- More than 90 per cent of the population living in low-income countries remains without any right to coverage in health. Globally, about 39 per cent of the population is lacking such coverage.

Source: ILO World Social Protection Report 2014/2015.

Box 1-6: Social protection floors

SDG target 1.3 commits to "Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable". ILO Recommendation No. 202 sets out that member States should establish and maintain national social protection floors as a nationally defined set of basic social security guarantees which secure protection aimed at preventing or alleviating poverty, vulnerability and social exclusion (ILO, 2012a). These guarantees should ensure at a minimum that, over the life cycle, all in need have access to at least essential health care and basic income security. These together ensure effective access to essential goods and services defined as necessary at the national level. More specifically, national social protection floors should comprise at least the following four social security guarantees, as defined at the national level:

- (a) access to essential health care, including maternity care;
- (b) basic income security for children, providing access to nutrition, education, care and any other necessary goods and services;
- (c) basic income security for persons in active age who are unable to earn sufficient income, in particular in cases of sickness, unemployment, maternity and disability; and
- (d) basic income security for older persons.

Such guarantees should be provided to all residents and all children, as defined in national laws and regulations, and subject to existing international obligations. Recommendation No. 202 also states that basic social security guarantees should be established by law. National laws and regulations should specify the range, qualifying conditions and levels of the benefits giving effect to these guarantees, and provide for effective and accessible complaint and appeal procedures.

Source: ILO, World Social Protection Report 2014/2015, p. 162.

example resulting in forced resettlement or not taking into account jobs that are available around slums but not close to resettlement areas⁶². As another example, the impacts of the Millennium Villages Project have been discussed among development practitioners, with a range of opinion regarding its effectiveness^{63, 64}.

1.5.4 Sectoral strategies

Many if not most development interventions ultimately focus on sectors or sub-sectors. Therefore, evaluating how such strategies aim to reach those left behind and succeed in doing so in practice is a critical first step to understand the challenges of implementing the 2030 Agenda. This section presents some of the key points that emerge from an investigation of existing scientific evidence on strategies used in a sample of sectors. Table 1-3 provide examples of strategies commonly used in some SDG areas and the extent to which they have been found to reach those left behind, based on existing literature. The full references on which the table is based can be found in Annex to this chapter. Clearly, it would be important to conduct similar investigations for other sectors, including: agriculture, rural development; industry and manufacturing; trade; information and communication technology; infrastructure development; energy; and transport.

It could be expected that evidence is available on the degree to which interventions in various sectors impact the poor, given that, at least since the adoption of the MDGs, the notion of "pro-poor" development strategies has been prevalent. As a consequence, the frameworks used

for evaluation of the impacts and effectiveness of such strategies have increasingly tended to incorporate poverty as one of the criteria by which strategies are assessed.

In practice, the limited review of the literature undertaken for this chapter seems to suggest that evaluations at the "meta" level (e.g. multi-projects, multi-country studies that systematically analyse the impacts of interventions in a comparable methodological framework) are quite rare. Such studies can be found for some sectors in scientific journals⁶⁵ and in reports produced by evaluation units of development institutions.⁶⁶ However, and pending more detailed investigation, they do not seem to exist for all relevant SDG areas and sub-areas. It also seems clear that even when such evaluations exist, they tend to use different criteria for measuring those left behind and for assessing the effectiveness of interventions in reaching them.

In some SDG areas, commonly used development objectives and interventions have the notion of leaving no one behind at their core. For example, providing universal access to water, sanitation, electricity, clean cooking fuels, child protection services, education and health are by definition objectives that focus on those who are 'left behind' with respect to those services. For example, universal access to primary education without discrimination has been at the forefront of international and national efforts⁶⁷.

As a cross-cutting issue and now as a stand-alone SDG, gender equality is one of the main objectives in ensuring that no one is left behind, since women and girls around

the world are often excluded. Even though gender equality is already embodied as an objective in many policy interventions, targeted efforts are often needed to ensure the inclusion of the furthest behind, for example by ensuring the security of girls and women in education institutions and on the journey to and from school, in particular during conflict and crises⁶⁸.

Health is also a good example of an area where reaching the furthest behind has been on the forefront of national and international policy discussion. At the national level, the imperative to leave no one behind in this area is epitomized in discussions on universal health coverage, which have matured in many countries over the past two decades. In addition to universal interventions and access provision, broad but targeted schemes, such as conditional cash transfer programmes aiming at tackling multiple deprivations simultaneously, by definition aim at ensuring that no one is left behind.

In other sectors, the alignment between strategies commonly used and “leaving no one behind” may be less natural. For example, payment for ecosystem services (PES) schemes, which have become a common tool for ecosystem management, do not generally have poverty alleviation as their primary objective, even though some of them have been found to benefit poor and marginalized communities. Indeed, it has been argued made that PES schemes may benefit the poor more when they are targeted on protecting the environment rather than on serving as a mechanism for poverty reduction⁶⁹. In agriculture, there has been a focus on the need to incorporate small-holder agriculture in policy frameworks and development interventions, by providing them with access to markets, to certification schemes, helping them to address non-tariff barriers, etc. The need to ensure that the legal and regulatory framework and the support system for agriculture that are put in place do not discriminate against smallholders is also increasingly recognized.⁷⁰

Even though sectoral strategies may be well aligned with the objective of leaving no one behind, they may still require concerted efforts in order to reach the furthest behind. For example, despite efforts made in the field of child protection to understand the magnitude, causes and consequences of sexual, physical and emotional violence in childhood, without additional targeted interventions to prevent and respond to such violence, victims will continue to be at increased risk of abuse, further compounding poor health and education outcomes and significantly impacting their productivity as adults, continuing the cycle of being “left behind”⁷¹. Similarly, despite efforts made to provide free access to education, without additional targeted interventions disadvantaged groups such as children and youth with disabilities will continue to be less likely to start school or attend school and complete schooling than other

children⁷². While facilitating access to safe drinking water in urban areas with existing infrastructure might be done with subsidies to facilitate connections to the network at affordable cost⁷³, individuals living in remote rural areas may not be reached by such efforts without targeted efforts to widen the network or to provide alternative water sources. Health provides clear-cut examples of an area where strategies that focus on reaching those furthest behind may sometimes be the “best” strategies from a pure efficiency sense.⁷⁴

On the one hand, interventions that aim at reaching the furthest behind first (e.g. marginalized groups and areas characterized by intensive disadvantage) may accelerate overall progress towards sustainable development. Interventions in health, access to water and sanitation and others focusing on access to basic services, have consistently been found to have extremely high social return on investment, with multiple benefits for health, household income, education and labor productivity.⁷⁵ And such interventions often make sense from a narrow cost standpoint. For example, as shown by the Global Energy Assessment, the cost of universal access to modern energy is one or two orders of magnitude lower than the cost of the transformations in energy systems that will be needed to keep climate change under control.⁷⁶

On the other hand, in some sectors reaching those furthest behind may be perceived as involving a trade-off with economic efficiency based on a utilitarian approach. For example, considering the hypothetical case of a health policy that has to allocate resources to different treatments, a utilitarian approach could allocate resources so that the average life expectancy of the whole society would increase the most. An approach that aims to leave no one behind may put more weight on the fact that rich and poor are affected by different types of diseases and may result in an allocation that maximizes the gain in life expectancy for each group. In other cases, the cost of reaching those furthest behind may be high, creating a trade-off between helping a larger number of poor or near-poor or fewer extreme poor.

From the evidence reviewed for this chapter (see Annex for details), it seems clear that in at least some areas of the SDGs, commonly used development interventions may have to be reassessed through the lens of reaching those left behind, and that in some cases, strategies that achieve this objective would not be the ones that are used today. The important point here seems to be the need for explicit recognition of the value that societies put on leaving no one behind, as this has a clear impact on the way alternative development strategies are compared and selected. In practice, this approach requires identifying the relevant groups of interest for policy (including those “left behind” according to agreed criteria), identifying which factors affect

Table 1-3: Examples of commonly used strategies and how they are aligned with 'leaving no one behind'

Topic	Commonly used strategies	Alignment with 'leaving no one behind'	Examples of strategies that aim to 'reach the furthest behind'
Nutrition	<ul style="list-style-type: none"> • Promotion of breastfeeding and nutrition for pregnant/breastfeeding women and adolescent girls • Promotion of complementary feeding with or without provision of food supplements • Micronutrient interventions • General supportive strategies to family and community nutrition • Reduction of disease burden. 	Interventions are usually delivered as universal programmes targeting pregnant and lactating women, adolescent girls, infants and young children.	Nutrition interventions that focus on the furthest behind, such as the therapeutic feeding for children suffering from severe acute malnutrition, are particularly effective when compared with other strategies. However, because stunting is difficult to reverse after 36 months of age, in some contexts, universal programmes before that critical age have been proven more successful than targeted interventions later in life.
Health	<ul style="list-style-type: none"> • Provision of primary health care • Prioritizing interventions at younger ages • Lowering the price of medicines • Diseases specific international action programmes 	<p>Universal health coverage attempts to guarantee comprehensive health coverage for the entire population.</p> <p>The need for efforts to combat "orphan diseases" such as neglected tropical diseases has been on the policy agenda for a long time.</p>	Some programmes of universal care are focused on reaching the furthest behind first. Examples include prioritizing areas with the highest social deprivation when building health centers, obligatory service in underserved areas for health care professionals, or providing specialized insurance schemes for those otherwise excluded.
Conditional cash transfers (CCTs)	<ul style="list-style-type: none"> • Cash transfers given to poor groups of the population on the condition of participation in schooling, natal care, and vaccination schemes 	CCTs are usually provided to poor families, aiming at enhancing the lives of both the parents by alleviating poverty but also increasing the human capital of the children.	Some schemes include unconditional cash transfers to the poorest families, others give additional support to youth that stay in school, tackling drop outs. Schemes can also be designed to target only marginalized groups, e.g. indigenous peoples.
Payments for ecosystem services (PES)	<ul style="list-style-type: none"> • Schemes that compensate people or communities to manage an environmental resource or service according to certain requirements. PES schemes are commonly used in areas related to climate change mitigation, watershed services and biodiversity conservation. 	The primary focus is on maintaining or restoring ecosystem services, not on poverty alleviation. However, schemes can benefit poor community managing ecosystems. Efforts to study the links between link PES and poverty reduction have developed in the past 20 years.	The precise design of the PES influences the distribution of payments across participating and non-participating groups. Hence, PES can be more or less focused on those furthest behind, depending on the case.
Access to shelter	<ul style="list-style-type: none"> • Direct provision of housing units (public sector) • Ownership and rental subsidy programmes • Slum upgrading programmes, including a comprehensive range of basic services in addition to shelter. • Reform of housing finance systems, including primary and secondary mortgage markets and rental markets. • Municipal finance • Urban planning and regulation 	<p>Traditional interventions in housing markets, both through direct provision of housing units and through subsidies, have not often reached the poorest.</p> <p>Traditional housing finance interventions aiming at increasing the depth of housing finance have not reached the poorest.</p> <p>Slums upgrading programmes clearly focus on those left behind, but have not kept pace with the rapid increase in the number of slum dwellers in past decades globally.</p> <p>Homelessness is still an issue in developed and developing countries alike.</p>	<p>The impact of interventions focused on slum dwellers depends on the design and implementation.</p> <p>The introduction of micro-finance for housing was an attempt to reach communities that did not have access to traditional banking services.</p>
Access to drinking water and sanitation	<ul style="list-style-type: none"> • Restoration and protection of water-related ecosystems that underpin the provision of freshwater supplies • Extension of networks to provide universal coverage of drinking water services • Water tariffs and associated subsidies (consumption, direct, connection subsidies) 	<p>Strategies that aim to provide universal access to safe drinking water are directly geared to leaving no one behind. However, extension of networks usually does not reach those furthest behind first. Many countries have met the MDG target relating to drinking water; yet, many still do not have access to an improved drinking water source.</p> <p>Water subsidies have often been found to be regressive; they do not reach those not connected to the network.</p>	In countries where the majority of the population has physical access, strategies to facilitate affordability of water become the main channel to reach those furthest behind. To the extent that those furthest behind live farthest from areas already served, strategies to extend water provisions may not spontaneously reach the furthest behind first. Doing so requires a deliberate prioritization of the most underserved areas and groups.

Table 1-3: (continued)

Topic	Commonly used strategies	Alignment with “leaving no one behind”	Examples of strategies that aim to ‘reach the furthest behind’
Persons with disabilities	<ul style="list-style-type: none"> • Anti-discriminatory laws and regulations • Quotas for persons with disabilities • Incentives for employers (tax credits, support for accommodation or workplace modifications) • Special supported employment, training programmes, and microfinance for self-employment • Increasing accessibility of public spaces 	Strategies aiming towards inclusion of persons with disabilities are by design aiming at leaving no one behind.	Targeted interventions can be used to reach those not otherwise included in broad-based programmes for supporting persons with disabilities. Examples include specialized services for children with disabilities in courts to facilitate access to justice; ensuring that educational materials on HIV/AIDS for youth are made in accessible formats such as videos with sign language; and providing additional unconditional cash-transfers to children with disabilities within conditional cash transfer programmes.
Education	<ul style="list-style-type: none"> • Free access to primary and secondary education • Increasing demand for education through initiatives such as cash transfers, school feeding programmes and take-home rations • Increasing the supply of schools and classrooms, investing in teachers’ quality and incentives • Investing in health and infrastructure 	Evidence-based policies and strategies to address exclusion in education include elimination of cost barriers through, for example, cash transfer programmes; provision of school meals/nutrition and health services; learning and teaching materials and transport services; second chance/re-entry programmes; inclusive school facilities; teacher training on inclusive education; and language policies to address exclusion.	Education strategies and policies have encompassed measures aiming to reach groups at a special disadvantage, investing additional resources in school districts located in disadvantaged neighbourhoods. Countries have adopted different strategies to enhance school enrolment of children with disabilities.

Source: Authors’ elaboration. For full references, see Annex.

the outcomes in each group, and allocating resources in a way that explicitly considers the outcomes of each group.

1.6 Conclusion – considerations for decision-makers

This chapter aimed to provide a reference frame for exploring the implications of the principle of “leaving no one behind” for the operationalization of the SDGs from a science-policy perspective. The chapter provided a limited review of how scientific evidence can inform decision-makers on three critical questions. First, it reviewed some of the concepts and methods used to identify those left behind in practice. Second, it pointed to existing reviews of the effectiveness of development interventions in targeting and reaching those left behind. Finally, it highlighted examples of development strategies used in various areas of sustainable development and what evidence tells us about their effectiveness in leaving no one behind, based on existing scientific reviews.

Many goals and targets across the 17 SDGs explicitly refer to specific objectives and actions that directly relate to leaving no one behind, as well as groups (of countries or people) that should be the object of sustained attention in this regard. In particular, such references are very frequent under goals that were within the scope of the Millennium Development Goals (MDGs), including poverty, gender, education and health, and means of implementation. In

those areas, considerations of inclusiveness in a broad sense have long been part of the main development discourse and practice, and actions and policies to address this dimension have become part of the standard development apparatus. Specific actions are also highlighted under other goals. For some goal areas though, specific measures to ensure that no one is left behind are not always fully specified in the associated targets.

Many criteria can be used to identify those left behind, whether within a country or across countries. In addition to the reference to certain groups (e.g., women, indigenous peoples, persons with disabilities, the youth, and others) and deprivation indicators focused on single areas or sectors, many indices of multiple deprivation exist, which incorporate social, economic and environmental dimensions. For example, multiple deprivation maps based on composite indicators have been used as an instrument of planning and management at different geographical levels, both in developed and developing countries. In practice, those “left behind” with respect to a particular dimension of the Agenda may be different groups in different societies. Further efforts to produce disaggregated data have been underlined as a critical step towards better identifying those left behind.

A variety of targeting methods have been used to reach those left behind. All need underlying data to be implemented, as well as administrative capacity in various institutions.

Available evaluations from different SDG areas all suggest that there are significant practical challenges in effectively reaching those left behind.

The chapter provides examples of strategies commonly used in some SDG areas and the extent to which they have been found to reach those left behind, based on existing literature. In many SDG areas, inclusive development strategies are the commonly accepted paradigm. Examples include drinking water, electricity and other basic services, where ensuring universal access is often an overarching objective. However, whether strategies succeed in reaching those left behind depend on many factors, from country-specific circumstances to their design, targeting methods and practical implementation. Among the examples of interventions explored in this chapter, those that are based on reaching the furthest behind first include: nutrition, where the core target of interventions in developing countries is those suffering the most from stunting; area-based interventions targeting the poorest locations; and strategies to provide shelter for homeless people. Clearly, it would be important to conduct similar investigations for other sectors, including: agriculture, rural development; industry and manufacturing; trade; information and communication technology; infrastructure development; energy; and transport.

Based on the limited evidence reviewed in the report, in many areas of the new Agenda, factoring in the imperative to leave no one behind in sustainable development interventions may not present insurmountable difficulties. Undertaking to systematically reach the furthest behind first may in some cases require a more significant departure from presently used strategies. Achieving success in this area is likely to require attention at three levels. First, better taking into account the interests of those left behind will require assessing the way in which strategies and policies are designed. This in turn may require the incorporation of enhanced understanding of the dynamics of poverty, inequality, marginalization, discrimination and vulnerability in a country- and place-specific context. This should also

involve ways to give more voice to deprived or marginalized groups in policy discussion and decision-making. The institutional dimension is clearly crucial in this, as argued in Chapter 4. Second, there will be a need to review, and possibly update, ways in which strategies are executed, with particular efforts made to reach the furthest behind, addressing gaps in administrative capacity and data to improve the targeting of programmes and addressing other obstacles that prevent progress. Third, at the highest level of decision-making in Government, taking the new Agenda at its word will require a consideration of how social objectives are balanced with other objectives, such as short-term economic efficiency. Ultimately, the priority given to those furthest behind will be reflected in the allocation of resources, both from the public and the private sectors.

Given the overarching importance of the concept of leaving no one behind in the 2030 Agenda, in going forward, it will be critical to systematically collect scientific evidence on how existing development strategies do indeed reach the furthest behind. A first step could be an inventory of existing meta-studies that attempt to review the effectiveness of development interventions in different SDG areas in reaching those left behind. Evaluations in different SDG areas use different criteria for defining and measuring those left behind or furthest behind and for assessing the effectiveness of interventions in reaching them. It could be worth assessing the costs and benefits of investing in more comparable frameworks for evaluating development interventions across the SDGs. This would likely be a significant undertaking in terms of methodology and costs. The reward might be a better grasp across the whole Agenda on how strategies put in place do indeed reach the furthest behind.

Other chapters of the report provide additional insights on aspects introduced in this chapter. Chapter 2 examines the links among resilience, infrastructure and inequality. Chapter 3 reviews technologies for the SDGs, with an emphasis on technologies for those left behind. Chapter 4 discusses inclusive institutions for the SDGs.

Endnotes

- 1 See for example: Taking income inequality reduction seriously: a pass-or-fail test for the Sustainable Development goals, IDDRI issue brief, 6/15, September 2015; Inequality and the 2030 Agenda for sustainable Development, Development Issues 4, Department of Economic and Social Affairs, October 2015.
- 2 In the UN, see for example HLCP, 2015, Equality and non-discrimination at the Heart of sustainable Development: Towards a UN System-wide shared framework for addressing inequalities and discrimination of the 2030 Agenda, HLCP positioning paper, November, CEB/2015/6.
- 3 A/RES/70/1, paragraph 4.
- 4 For references, see e.g. United Nations, 2013, Inequality Matters, Report on the World Social Situation 2013, Department of Economic and Social Affairs, New York; and World Bank, 2013, Inclusion matters: The foundation for shared prosperity, Washington D.C.
- 5 United Nations, 2002, Johannesburg Declaration and Plan of Implementation, New York.
- 6 The Oxford dictionary online defines "inclusiveness" as "(T) he quality of covering or dealing with a range of subjects or areas" or "the quality of including all sections of society". In turn, "inclusive" is defined as "including or covering a broad array of things", as "containing a specified element as part of a whole", as "not excluding any section of society or any party involved in something", and finally, when referring to language, as "deliberately nonsexist, especially avoiding the use of masculine pronouns to refer to both men and women".
- 7 Sen, A., 1999, *Development as Freedom*, New York: Oxford University Press.
- 8 See for example HLCP, 2015, Equality and non-discrimination at the Heart of sustainable Development: Towards a UN System-wide shared framework for addressing inequalities and discrimination of the 2030 Agenda, HLCP positioning paper, November, CEB/2015/6.
- 9 Other research in development and conflict studies differentiates between vertical and horizontal inequalities, showing how inequalities – particularly deep inequalities between ethnic and religious groups – whether in income, access to economic resources, social services, political participation or justice – can threaten social cohesion, radicalize groups and heighten the risk of tensions escalating into political crisis and violent conflict. See e.g. Henk-Jan Brinkman, Larry Attree and Sasa Hezir, 2013, Addressing horizontal inequalities as drivers of conflict in the post-2015 development agenda, mimeo, Frances Stewart https://www.ifw-kiel.de/konfer/2006/preg/stewart_langer.pdf, CEB paper. The concepts of horizontal equity and vertical equity are not specific to the conflict and development field.
- 10 Huq et al., Does Aquaculture Sector Concern about Women Empowerment with Sustainable Development? A Situation Analysis of Coastal Regions of Bangladesh, Brief for GSDR, 2016; Rao et al., Gendered vulnerabilities to climate change: Insights from the semi-arid regions of Africa and Asia, Brief for GSDR 2016.
- 11 Full Participation Project: No Ceilings Report: 2015, Clinton Foundation and Bill and Melinda Gates Foundation.
- 12 Djoudi et al., At the intersection of inequalities, Lessons learned from CIFOR's work on gender and climate change adaptation in West Africa, Brief for GSDR 2016; Larson et al., Can Safeguards Guarantee Gender Equity? Lessons from research on women in early REDD+ implementation, Brief for GSDR 2016; Thuy et al., Gender mainstreaming in REDD+ and PES - Lessons learned from Vietnam, Brief for GSDR 2016.
- 13 The 2030 Agenda also contains wording which potentially restricts the promise of 'ensuring that no one is left behind'. E.g. Target 5.4: Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family **as nationally appropriate**.
- 14 Intergenerational equity has been a central tenet of sustainable development since the concept was developed, most famously recognized in the Brundtland definition. See Matson, P., W. C. Clark, K. Andersson, 2016, *Pursuing Sustainability: A Guide to the Science and Practice*, Princeton University Press, Princeton.
- 15 The most commonly used definition of poverty counts the number of people living below a certain income threshold. Based on the revised World Bank definition, less than \$1.9 per day (USD PPP) is extreme poverty, less than \$3.1 is moderate poverty. Absolute poverty lines such as those above are often based on estimates of the cost of basic food needs (i.e., the cost a nutritional basket considered minimal for the healthy survival of a typical family), to which a provision is added for non-food needs. Relative benchmarks, on the other hand, reflect the belief that important deprivations are to be judged relative to the well-being of the whole society, approximated by the income level of the household at some point of the income distribution. Many national poverty lines are based on such relative measures.
- 16 <http://hdr.undp.org/en/content/multidimensional-poverty-index-mpi>.
- 17 <http://www.oecdbetterlifeindex.org/#/111111111111>.
- 18 <http://www.socialprogressimperative.org/wp-content/uploads/2016/04/2015-Methodology-Report.pdf>.
- 19 See Paes de Barros, R., F. H. Ferreira, J. R. Molinas Vega, and J. Saavedra Chanduvi. 2009. Measuring Inequality of Opportunities in Latin America and the Caribbean. Washington DC: Palgrave MacMillan and The World Bank. The composite index measures how personal circumstances impact a child's probability of accessing key infrastructure services. It is made of two elements: (i) the level of coverage of basic opportunities necessary for human development (such as access to primary education, water and sanitation, or electricity); and (ii) the degree to which the distribution of those opportunities varies across variables such as location (urban versus rural), gender, income, household size, education of household head, and gender of household head.
- 20 E.g. A small fraction of wealthy households in developed countries choose not to have access to television in their homes, even though for a long time, the rate of equipment of households in TV sets was considered as an indicator of "progress".
- 21 For a discussion and references, see Matson, P., W. C. Clark, K. Andersson, 2016, *Pursuing Sustainability: A Guide to the Science and Practice*, Princeton University Press, Princeton.
- 22 E.g., basic indicators such as: being above or below the national poverty line; minimal calorie intake; stunting; no access to safe drinking water and sanitation; access to clean cooking fuel; access to electricity; fall into this category.

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- 27 See the Report of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators, E/CN.3/2016/2/Rev.1, Available here: <http://unstats.un.org/unsd/statcom/47th-session/documents/2016-2-SDGs-Rev1-E.pdf>.
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- 34 See Matson, P., W. C. Clark, K. Andersson, 2016, *Pursuing Sustainability: A Guide to the Science and Practice*, Princeton University Press, Princeton.
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CHAPTER

2

THE INFRASTRUCTURE – INEQUALITY – RESILIENCE NEXUS

The 2030 Agenda attributes crucial importance to the interlinkages and integrated nature of the SDGs. Goals and targets are interlinked and their formulation highlights the connections between them. Drawing from the work of the scientific community, this chapter examines the nexus between three specific areas that are explicitly interlinked in the Agenda: infrastructure, inequality and resilience (see Box 2.1). Better understanding of that nexus is important because it addresses critical commitments of the 2030 Agenda. First, the pledge that no one will be left behind, which as discussed in the previous chapter; second, the promise to take bold and transformative steps needed to shift the world onto a sustainable and resilient path; and third, the commitment to adopt policies to increase the quality and resilience of infrastructure.

This chapter aims to highlight the main channels of interconnection among these three areas and to synthesize the results of scientific analyses of the synergies and trade-offs among them. The chapter continues the nexus approach adopted in the previous two editions to the Report, highlighting the need for integrated approaches to sustainable development by showing how actions in one area of the SDGs can affect other areas. The chapter aims to promote the science-policy interface by bringing to the attention of policymakers how key interlinkages are analysed by scientific community, while providing the scientific community with some key policy questions and highlighting areas that may need further research.

Infrastructure is one of the areas that are generally considered as a public good, and as such, its provision or regulation is usually the responsibility of governments.¹ The consideration of the nexus provides policy-relevant information that can assist policymakers to further develop infrastructure while reducing inequality and increasing resilience. It can also strengthen the capacity of policymakers and practitioners to approach development in an integrated way, by providing concrete examples.

The following observations further underline the importance of the nexus:

- There are large disparities in access to infrastructure: Worldwide, over 1.1 billion people still have no access to electricity,² 663 million people lack access to clean water, and 2.4 billion do not have adequate sanitation.³ About one third of the world's population is not served by all-weather roads.⁴
- Closing those disparities would require large investments: The global infrastructure gap is estimated to amount to \$1-1.5 trillion annually in developing countries.⁵
- Investment in infrastructure should be mindful of its long lasting effects: Estimated useful life of infrastructure ranges from 20 years for roads to over 100 years for concrete bridges, sewer and water structures.⁶
- The need to make infrastructure resilient to disasters: Since 2010, disasters caused by natural hazards have accounted for over US\$ 900 billion in economic damage, mostly in terms of damage to infrastructure.⁷

Extensive bodies of literature have focused on each of the three areas of the nexus. For example, infrastructure has received significant attention in development circles, due to its perceived critical role in spurring economic growth and development. Yet, scientists focusing on each of those distinct fields, typically hail from different communities, making links between the three areas less commonly studied than any of the three areas taken in isolation.

This chapter was prepared based on a broad call for inputs, reaching out to scientists and experts who have published in peer-reviewed journals on topics related to the nexus, as well as other experts within and outside of the United Nations System. Scientists were invited to contribute to the chapter by identifying and describing interlinkages between infrastructure, inequality and resilience, identifying synergies, trade-offs and constraints, and providing evidence of the empirical strength of the interconnections. This was complemented by the analysis of scientific articles related to the nexus. Clearly, the analysis is not exhaustive but serves to highlight the broad range of research and scientific perspectives that exist in relation to the nexus.

The methodology used is described in Annex 2.

Given that the nexus is comprised of three broad areas that may be defined differently by various scientific disciplines, this chapter adopts the working definitions listed in Table 2-1. As discussed in Chapter 1, inequality is characterized by discrimination and the disparity in opportunities or outcomes between people or groups of peoples. Similar to poverty, inequality is multidimensional, including dimensions such as education, culture, health, nutrition, security, power, social inclusion, income, consumption and assets.⁸

Infrastructure, in the broader sense, is a means to fulfill a human need.⁹ It is composed of basic assets and objects that, in the aggregate, are deemed essential for the functioning of society and the economy. The scope of infrastructure considered in this chapter comprises basic services such as water, sanitation and energy, and connectivity infrastructure, including roads, transport systems, and information and communication technologies.¹⁰

Resilience is an attribute of such complex systems as ecosystems, people's livelihoods, cities and infrastructure, and is usually defined as the ability of a system to adapt to a shock and maintain its core functions.¹¹ In this chapter, the focus is on the resilience of people as characterized by their ability to adapt to economic, social and environmental shocks so they could continue to lead the life that they have reason to value.

The interlinkages within the nexus indicate how a change in one area affects, and is affected by, other areas. Interlinkages can result in synergies when an improvement in one area results in an improvement in another area. For example, improvements in the quality of rural roads may increase access of poorer households to markets and job opportunities, which may reduce income inequality and increase resilience.

On the other hand, interlinkages can result in trade-offs when an improvement in one area results in a decline in another area. For example, improvement in the quality of rural roads could create incentives for the specialization of agricultural households in a particular crop, which would reduce the diversity of their livelihoods and, in turn, their resilience to shocks. It may also be possible that households that are already better-off would benefit the most from the improvement in the roads given their initial advantage in terms of stock of capital, which could contribute to increase inequality.

As illustrated by these examples, interlinkages in the nexus are complex and conditional to existing levels of infrastructure, inequality and resilience. This chapter highlights some of the key interlinkages based on evidence from science.

Table 2-1: Working definitions

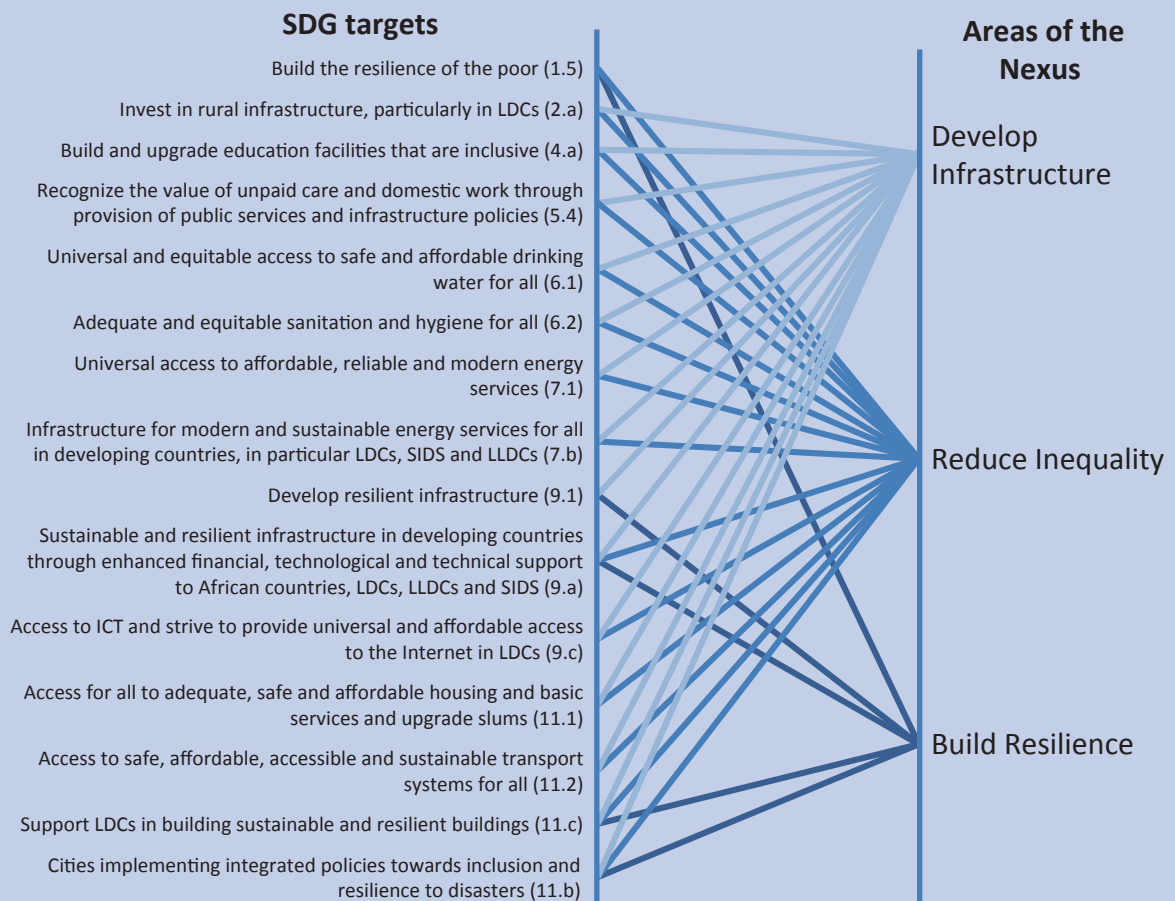
Inequality	Infrastructure	Resilience
The disparity in opportunities or outcomes between people or groups of peoples	Basic assets and objects that are considered essential for the functioning of the society and economy	Ability of people to withstand and adapt to economic, social or environmental shocks so they can continue to lead the life they have reason to value

Source: Authors.

Box 2-1: Infrastructure, inequality and resilience nexus in the 2030 Agenda

The areas of infrastructure, inequality and resilience are individually addressed in many goals and targets of the SDGs. The interlinkages between these areas are explicitly highlighted in 15 SDG targets. The majority of those targets are related to providing universal access to infrastructure to reduce inequality (e.g. drinking water, sanitation, modern energy services, ICT and Internet, housing, and transport). Another two targets link resilience to infrastructure (developing resilient infrastructure – target 9.1) and to inequality (building resilience of the poor – target 1.5). Finally, the interlinkage of the three areas of the nexus is highlighted in three targets: facilitate sustainable and resilient infrastructure in developing countries through enhanced financial, technological and technical support to African countries, LDCs, LLDCs and SIDS (9.a); support LDCs in building sustainable and resilient buildings (11.c); and increasing the number of cities that implement integrated policies towards inclusion and resilience to disasters (11.b).

Figure A. SDG targets directly related to the nexus



Source: Authors.

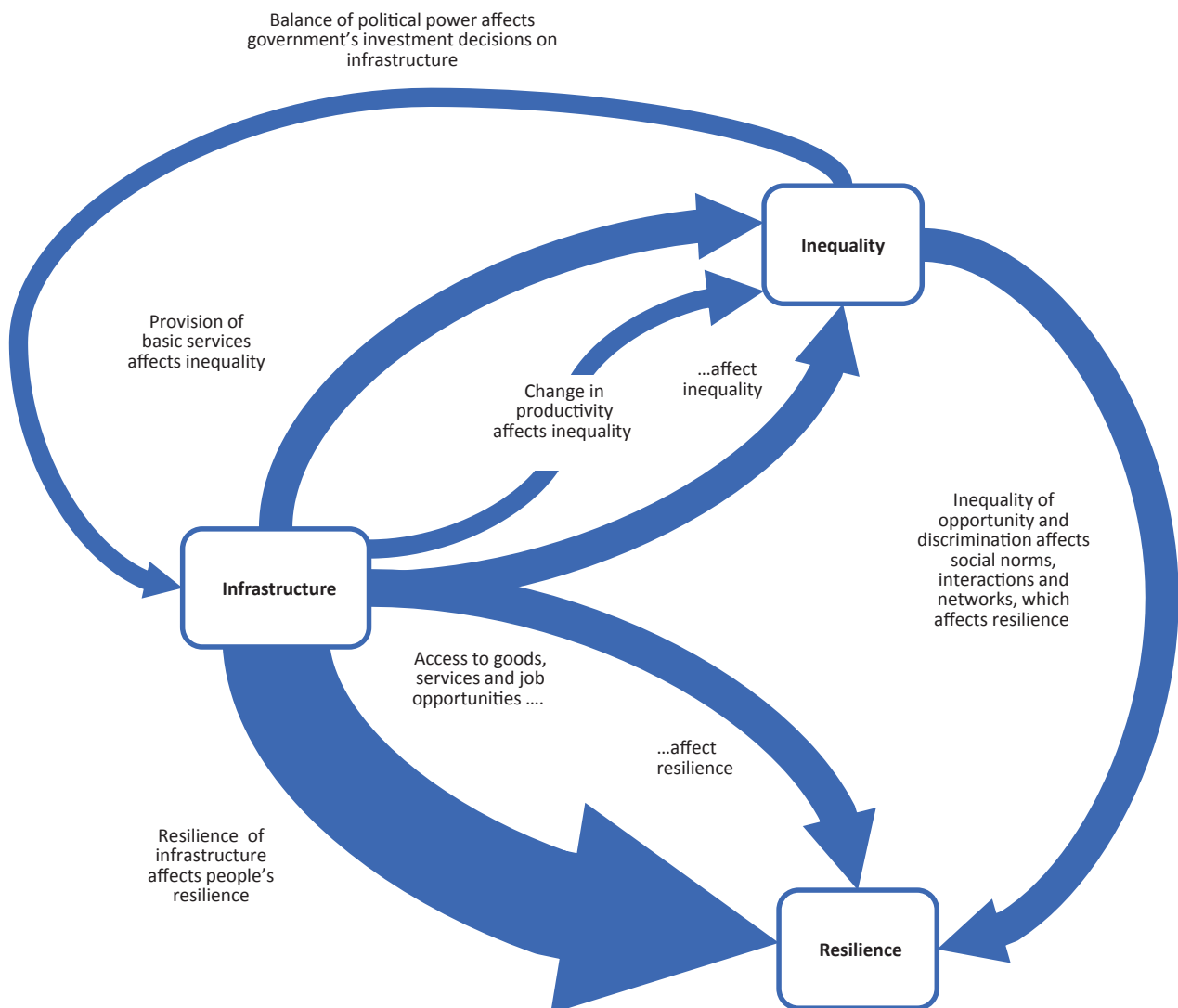
2.1 Key interlinkages

Consultation with experts and the review of scientific literature have identified several links between the elements of the infrastructure, inequality and resilience nexus, which for simplification were grouped in the key interlinkages presented in Figure 2-1. The Figure was designed with a view to breaking down the various causal links that exist between the three areas under consideration (represented by the boxes). The arrows between boxes indicate the interlinkages; the nature of the links is indicated in the text near the arrow. For example, one arrow links infrastructure

to inequality and indicates that provision of basic services affects inequality. The sizes of the arrows indicate the relative amount of illustrative research focusing on a particular linkage, based on the inputs by contributing experts and meta-review conducted in preparation for the chapter. The links presented were selected by clustering the information provided by experts into logical relationships. Given the complexity of the nexus, the map is only illustrative and is not intended to include all the relevant links.

The interlinkages identified by experts and described in Figure 2-1 can be summarized as follows:

Figure 2-1: Evidence map of the infrastructure – inequality – resilience nexus



Source: Authors elaborations based on inputs by experts and literature review.

Infrastructure affects inequality of outcomes and opportunities through three main channels. First, infrastructure that provides basic services such as water, sanitation and electricity may affect inequality depending on the quality, design, coverage, accessibility and distribution of that infrastructure. Infrastructure such as irrigation, electricity, ICT, and roads increase productivity and reduce trade costs, which affects the structural dynamics of the economy, including levels of income and distribution of jobs, and may have an effect on inequality. The third channel is through connectivity infrastructure such as roads and ICT, which affects the access of people to goods, services and job opportunities, and therefore may have an effect on inequality.

On the other direction of the interlinkage, inequality of outcomes affects infrastructure through its effect on the balance of political power and, consequently, government decisions and the involvement of private companies on the provision of basic services, including infrastructure.

Infrastructure affects resilience through its effect on access of people to goods, services and job opportunities, which have an effect on the ability of people to adapt to shocks. The quality, design, distribution, interrelation and operation of infrastructure also affect the resilience of the infrastructure itself, which has an effect of people's resilience to economic, social and environmental shocks.

Inequality of opportunity and discrimination affect resilience through their impacts on social norms, interactions and networks, which have an effect on the ability of people to adapt to shocks.

Two potential links in the nexus seem not to have received much attention from the contributing experts and literature reviewed. They are the links from resilience to inequality and to infrastructure.¹² Further research is required to uncover the reasons for that gap, but a possible cause may include the fact that there is still an ongoing debate on the ways to measure resilience, which has been noted by many experts and is reflected in the sizeable number of publications dedicated to that the topic.¹³

2.1.1 Infrastructure and inequality

Contributing experts noted numerous studies related to understanding the interlinkages from infrastructure to inequality. Table 2-2 further details these interlinkages, with contributions from experts of examples, illustrative research and suggested areas for further research.¹⁴

Infrastructure has historically been considered key to economic growth and development,¹⁵ but research on the link between infrastructure and inequality has shown a more nuanced story.¹⁶ Econometric studies at the aggregate level have found that infrastructure development has positive

effects reducing poverty¹⁷ and income inequality.¹⁸ However, the impacts of infrastructure on income inequality may differ based on the type of infrastructure and the income category into consideration.¹⁹ The mechanisms through which these effects operate remain relatively unexplored through econometric techniques.²⁰

Microeconomic studies that evaluate the impact of particular infrastructure interventions have found that physical infrastructure in roads and communications facilitates spatial access and information flows, raising labour mobility, advancing rural non-farm economies, and reducing the incidence of poverty in some geographic areas.²¹ Other empirical studies have found that improved access to infrastructure services can raise the income of the poor through its impact on human capital, specifically education and health outcomes, and that public infrastructure provides a boost for local community and market development.²²

Table 2-3 summarizes the potential impact of infrastructure in various development areas as found in the literature, looking at the relation between infrastructure and areas related to the SDGs. The magnitude of the effectiveness is given as large (+++/---), moderate (++/--), small (+/-) or neutral (0).²³ Infrastructure is found to reduce income poverty and to affect non-income aspects of poverty, contributing to improvements in health (SDG 3), nutrition (SDG 2), education (SDG 4), and women empowerment (SDG 5).²⁴ The magnitude and direction of the effect of infrastructure on income inequality depends, as mentioned above, on such factors as the type of infrastructure.

Clearly, such analysis includes a large dose of arbitrary judgment but it serves to illustrate the complex nature of the impact of infrastructure on the distribution of outcomes and opportunities. In summary, the table shows that in general there is a positive effect of the quantity and quality of infrastructure on the level of attainment in different areas of development, but the effects on inequality, illustrated by the effects on income inequality, are not always positive. They depend on several factors such as the initial level of inequality of opportunities and outcome that affect the extent to which people benefit from the improvements in infrastructure

Many studies have also assessed the impact of infrastructure on inequality through the effects of the former in increasing productivity and reducing trade costs, which affects the structure of the economy and the levels of income and distribution of jobs. A considerable share of that research focuses on the rural context. In general, development of infrastructure improves agricultural productivity and reduces rural poverty. For example, research in China, India, Philippines, Thailand, and Viet Nam shows that

Table 2-2: Important interlinkages from infrastructure to inequality

Infrastructure→inequality Interlinkages	Illustrative research	Areas for further research suggested by experts
<p>The quality, design, coverage, accessibility and distribution of infrastructure that provides basic services affects inequality</p> <p><i>Examples:</i></p> <ul style="list-style-type: none"> • Historical inequities can be perpetuated as an unintended result of the method of delivery of essential services such as water and sanitation • In urbanizing regions, emphasis on basic service and environmental service infrastructure building on the core area and its neglect in the peri-urban has structured placed-based inequalities. 	<ul style="list-style-type: none"> • Analysis of the role of income, maternal education and social capital on how sanitary infrastructures affect child health.²⁵ • Development of policy and practice guideline for local, provincial and national government to promote the expansion and improve the operations at wastewater treatment works.²⁶ • Analysis of the connection between access to water, equity and development.²⁷ • Analysis of the multiple practices and arrangements by which the peri-urban poor access water and sanitation to help in the identification of service delivery options that work for them.²⁸ • Analysis of the consequences of water tariffs that use sliding-scale prices to assess the aggregated consumption of households in terms of equity.²⁹ 	<ul style="list-style-type: none"> • Analysis of the key factors that improve the use of infrastructure and reduce inequities.
<p>Infrastructure increases productivity and reduce trade costs, which affects the structural dynamics of the economy, including changes in levels of income and distribution of jobs, and may have an effect on inequality</p> <p><i>Examples:</i></p> <ul style="list-style-type: none"> • Construction of rural roads had led to increased agricultural production. • Coverage and reliance of electrification increase productivity of economic activities. • Better roads are associated with lower transport costs. 	<ul style="list-style-type: none"> • Analysis of the impact of infrastructural investments in roads, electricity and irrigation on agricultural productivity.³⁰ • Analysis of the effect of inadequate provision of public Infrastructure and services on private investment.³¹ • Analysis of the benefits of rehabilitating rural roads for enhancing income opportunities for the rural poor.³² • Analysis of the impact of agricultural extension and roads on poverty and consumption growth in the rural context.³³ • Impact evaluation of interventions in support to rural transport infrastructure.³⁴ • Case studies on smallholder agriculture trends, constraints and opportunities.³⁵ • Analysis of the impact of rural roads on poverty.³⁶ 	<ul style="list-style-type: none"> • Direct impacts of investment in electricity and telecommunications infrastructure on agricultural productivity. • Analysis of impact of rural infrastructure on long-term changes related to crops portfolios, technological changes at both agricultural activities level and non-agricultural activities level, and the change in consumption patterns.
<p>The quality, design, coverage, accessibility and distribution of connectivity infrastructure affect people's access to goods and services, and job opportunities, which have an effect on inequality</p> <p><i>Examples:</i></p> <ul style="list-style-type: none"> • Transportation infrastructure may deepen inequalities based on its absence, its design and its consequences to better policies enhancing development. • Rural and poor villages without efficient connections (infrastructure) may perpetuate their isolation hampering income convergence across the country and even enlarging inequalities. • Infrastructure may drain activity of less dynamic nodes and concentrate activity to the largest more dynamic nodes. • Access to Internet and mobile telephony increase the access to goods, services and job opportunities. 	<ul style="list-style-type: none"> • Analysis of causes and effects of the broad pattern of gender disparity in transport access and use.³⁷ • Analysis of the impact of roads on poverty reduction.³⁸ • Analysis of the infrastructure and poverty linkages.³⁹ • Analysis of the impact of transport sector on maternal and child mortality development goals.⁴⁰ • Empirical Investigation on the effect of volume and quality of infrastructure in income distribution.⁴¹ • Assessment of the historical influence of housing policies on social inequality, disadvantaged neighbourhoods and transport deprivation.⁴² • Analysis of renewable energy-based electrification projects in reducing social inequalities and improving people's well-being.⁴³ 	<ul style="list-style-type: none"> • Besides better transportation, analysis of other factors may help increase adequate and affordable housing opportunities in major cities. • Analysis of the interrelation between road access and migration. • Compare financial and time costs for poor and non-poor households to access all forms of health intervention for improved maternal and child health outcomes. • Consideration of long-term population changes into the design of urban infrastructure to reduce vulnerability and exclusion of aging population.

Source: Authors, based on inputs by experts and literature review.

Table 2-3: Infrastructure's potential impact on key development areas

	Income poverty	Education	Gender parity in education	Child and infant Mortality	Maternal Health	Communicable disease	Environmental protection	ICT and trade	Income Inequality
Infrastructure:									(-, +++) ^{abcdef}
Transport (local)	+++	++	++	+	+		+	+	(--, +++) ^{agh}
Transport (regional)	+++	+	+	++	+	+	--	+++	
Modern energy	+++	+	+	++	+	+	++	+	(--, +++) ^{afh}
Telecom	++	+	+	+	+	+	+	++	(0, +) ^{ahi}
Water (private use)	++	++	+	+++	+	+	+++	+	(+, +++) ^{ad}
Sanitation	+	+	++	+	+	+	++	+	+++ ^d
Water management	+++		+	+			++		

Source: Willoughby, C., (2004). Infrastructure and the MDGs, sponsored by DFID, unless noted otherwise. a - Calderón & Chong (2004);⁴⁴ b - Calderón & Servén (2004);⁴⁵ c - Seneviratne & Sun (2013);⁴⁶ d - Calderón & Servén (2008);⁴⁷ e - Calderón & Servén (2010);⁴⁸ f - Majumder (2012);⁴⁹ g - Khandker & Koolwal (2007);⁵⁰ h - Bajar & Meenakshi (2015);⁵¹ i - Lopez (2004).⁵²

Notes: The magnitude of the effectiveness is given as large (+++/---), moderate (++/-), small (+/-) or neutral (0). Large is thought as more than 20% improvement with significant infrastructure development or more than 0.2 point increase with 1 point infrastructure increase. Moderate is considered as 10-20% improvement or 0.1-0.2 point increase, and small is 5-10% improvement or 0.01-0.1 point increase that is statistically significant. The values for inequality denote the range of infrastructure development's impact on income\consumption inequality. The first value refers to the most negative effect identified, and the second value refers to the most positive.

inequality is statistically lower in irrigated areas⁵³ with higher agricultural output per worker.⁵⁴

Experts also noted that infrastructure provides different opportunities and challenges depending on where and to whom it is intended.⁵⁵ For example, in the rural context, certain types of infrastructure have a higher impact. Many rural and remote areas are cut off from economic opportunities, markets, and public services, which locks residents in low productivity and poverty. Experience from Bangladesh, Cameroon, China, Ethiopia, India, Viet Nam and other countries shows that investment in secondary rural roads tends to have positive effects on the private sector productivity,⁵⁶ poverty reduction,⁵⁷ school enrolment,⁵⁸ access to health services,⁵⁹ and economic growth,⁶⁰ and comparison studies have found a higher benefit to cost ratio than investment in higher-volume roads.⁶¹ Better rural infrastructure also facilitates women's free movements and can lead to empowerment.⁶²

Research related to the infrastructure-inequality link has also explored how traditional inequalities can be perpetuated as an unintended result of the method of delivery chosen for essential services such as water and sanitation. For example, inequalities can be reinforced if service charges or uses fees do not take into consideration disparities in income. Elements of equity in access to and use of water and the distribution of the impacts of interventions in water resource development include: social equity between different groups of people living in the same location; spatial equity between people living in different regions; equity access between men and women efforts to access and use water, and its benefits; and inter-generational equity in enjoyment of water resources.

Transportation infrastructure may also deepen inequalities depending on its design, by draining activity from less dynamic nodes and concentrating it in to the largest, more dynamic nodes. There is also considerable research on how

some transport infrastructure may benefit high income users who make use of private cars while some others may have wider economic effects improving welfare of a larger amount of the population reliant on public services, particularly those with low income in developing countries.

Regarding the link from inequality to infrastructure, there is the overall sense that investments and the quality of services favour wealthier areas and that the design of infrastructure and the operation of public services tend to follow the wider balance of power (Table 2-4). Experts also noted a large literature on the politicised basis behind the production of the uneven landscape of urban areas, especially cities that experienced rapid expansion without inclusive policies, which shows the persistence and reinforcement of social and spatial inequalities.

2.1.2 Infrastructure and resilience

The interlinkages from infrastructure to resilience account for almost half of the research identified by contributing experts as related to the nexus. Examples of illustrative research are shown in Table 2-5.

In the experts' view, there seems to be a high level of knowledge on how the quality, design and distribution of infrastructure affect the resilience of infrastructure to shocks by natural hazards. By damaging the infrastructure and its functionality, disasters also impact the socio-economic fabric of communities. Quantitative models predicting impact of disasters have been developed by many research groups. However, although much is known in the case of more predictable and lower intensity events, technology and countermeasure strategies are still being developed for making infrastructure resilient to more severe disasters.

There is also a significant focus of research on the so called critical infrastructure, such as interurban transport, and

electricity and ICT infrastructure, whose disruption causes major negative effects on the economy and functioning of society. The complex nature and high interconnectedness of these infrastructures makes them particularly vulnerable to “chain reaction” effects during crisis.⁶³ Contributing

experts noted that some nations have conducted mapping of infrastructure dependencies and redundancies, which has advanced the understanding of the interdependencies across different types of infrastructure.

Table 2-4: Important interlinkages from inequality to infrastructure

Inequality → infrastructure		
Interlinkages	Illustrative research	Areas for further research suggested by experts
<p>Inequality affects the balance of political power and, consequently, government decisions on the provision of public services, including infrastructure</p> <p><i>Examples:</i></p> <ul style="list-style-type: none"> Investments and the quality of services favour the wealthier, regular areas. The design of urban infrastructure and the operation of public services tend to follow the wider balance of power. The needs of people living far from central areas (State capitals and main cities) receive less attention from public interest litigators who could help them vocalizing their claims. 	<ul style="list-style-type: none"> Development of framework that is able to capture the multidimensionality of the relations between nature and society increasingly mediated by the state.⁶⁴ Analysis of empirical relationships between spatial factors and travel behaviour for men and women in a cross-section of low-income communities in large metropolitan areas.⁶⁵ Analysis of human rights, inequality and public interest litigation on provision of sanitation.⁶⁶ Analysis of centralization as a determinant of government investment in infrastructure.⁶⁷ Study of the colonial roots of inequality in the access to water in urban context.⁶⁸ 	<ul style="list-style-type: none"> The political, ideological and operational influences behind investments and urban planning, comparing countries and cities in the Global North and in the Global South. How to make sanitation policies a topic politically appealing for governments.

Source: Authors, based on inputs by experts and literature review.

Table 2-5: Important interlinkages from infrastructure to resilience

Infrastructure → resilience		
Interlinkages	Illustrative research	Areas for further research suggested by experts
<p>The quality, design, distribution, interrelation and operation of infrastructure affect the resilience of the infrastructure itself, which has an effect of people's resilience to economic, social and environmental shocks.</p> <p><i>Example:</i></p> <ul style="list-style-type: none"> The design of urban infrastructure can influence social vulnerability. Pre-event assessment of vulnerability and resilience can lead to better infrastructure design and retrofit choices. The functionality of interurban traffic infrastructure is critical for the economic efficiency of a society. To fulfil this task, structures have to be resilient as well as sustainable. The recovery strategy after natural disasters affects resilience. Climate variability/change as well as sea level rise impact urban infrastructure that was designed long time ago with design criteria assuming stationarity. Planning and urban design strategies can increase the resilience of cities to climate change impacts. Older infrastructure is less resilient and more susceptible to failure due to extreme weather. 	<ul style="list-style-type: none"> Review of coastal disaster risk management, engineering analysis of infrastructure resilience to natural disasters, analysis of threats and assessment of vulnerability.⁶⁹ Development of strategic framework for assessing organizational and network resilience of critical infrastructure.⁷⁰ Analysis of critical Infrastructure dependencies to determine how such infrastructure is affected when another critical infrastructure fails.⁷¹ Development of unified approach for addressing resilience and sustainability of civil infrastructure.⁷² Development of approaches for identifying the trade-offs between quickly restoring infrastructure services versus taking time to consider and consult on alternative options.⁷³ Development of methods to quantify the resilience of water networks.⁷⁴ Analysis of factors that affect the resilience of electrical power distribution infrastructures.⁷⁵ Resilience assessment of interdependent infrastructure systems, and analysis and modelling of optimum strategies to their joint restoration after failure.⁷⁶ Development of models to quantify the effects of changes in international production from a disruption in supply chain caused by natural disasters.⁷⁷ Case studies on the potential effects of failure of heavily used, outdated locks and dams.⁷⁸ Development of dynamic framework to assess multi-regional, multi-industry losses due to disruptions on commodity flow on the waterway networks, including ports and waterway links.⁷⁹ 	<ul style="list-style-type: none"> How to truly build a multi-layer protection system. The issue of rapid recovery vs improving long-term resilience. Quantitative measures to describe the relationship between structural design, resilience and sustainable development in model based approaches. Evaluation of different approaches to public-private partnerships (PPP) and relationship to governance of critical infrastructure. Methodologies that can quantify social and economic damage. Different ways in which to provide incentive to increase resilience of infrastructure. Interrelations between different kinds of infrastructures. Unification of concepts of infrastructure resilience and sustainability. Quantitative assessments have mostly been done for the various sectors in isolation. Research on infrastructure interdependencies and resilience is required. Development of specific water distribution network infrastructure adapted to earthquakes (automatic sluice valves, buried tanks for firefighting, special joints for absorption of displacements, etc.). A more systematic understanding of the required adaptation measures for ports and other critical transport infrastructure, in the light of the projected impacts of climate variability and change.⁸⁰

Table 2-5: (continued)

Infrastructure→resilience		
Interlinkages	Illustrative research	Areas for further research suggested by experts
<p>The quality, design, distribution and operation of infrastructure affect people's access to goods and services, including natural services, and job opportunities, which have an effect of people's resilience to economic, social and environmental shocks.</p> <p><i>Examples:</i></p> <ul style="list-style-type: none"> • Location and concentration of basic service infrastructures such as pipe water system and drainage system, and paved roads is related to the vulnerability and resilience of certain areas to natural disasters such as flooding. 	<ul style="list-style-type: none"> • Proposal of resilience-based approach for assessing sustainability of regions to changes that threatens to cross biophysical, economic, and social thresholds operating at different scales, with possible knock-on effects between them.⁸¹ • Development of methods for evaluation of performance of water supply utilities under varying climatic condition using reliability, resilience and vulnerability metrics.⁸² • Analysis of the relationship between socio-economic development and water resources management strategy to attain sustainability in water management.⁸³ 	<ul style="list-style-type: none"> • Sustainable urbanism design. • The co-production of 'natural' disasters and vulnerability. • Analyses linking infrastructure like irrigation works, or other connectivity between communities and broader trade networks, and resilience at community and national scales. • How the design of infrastructure should encourage change of habits that are helpful to local populations such as walkability (encourage individuals in general to walk, which should directly help them exercise).

Source: Authors, based on inputs by experts and literature review.

Underlining much of that research is the view that the shape and structure of infrastructure networks affect how resilient they are against shocks. For example, many infrastructure networks tend to be formed by continuously adding new segments to existing parts of the network that are already well connected.⁸⁴ That fact is important because these types of networks are robust to random failure but vulnerable to failure on nodes with many links. Public transport networks, for example, seem to be robust under random failure but vulnerable to more targeted shocks that disrupt nodes that are more connected or more central in terms of having largest influence on the available paths in the network.⁸⁵ Other infrastructure may also be affected in this way depending on their structure.⁸⁶

Experts also noted that recovery strategies implemented after natural disasters affect resilience and can lead to increased social vulnerability,⁸⁷ therefore substantial research is going in the direction of optimizing the various phases of disaster management. For example, considering that pre-event assessments of vulnerability and resilience can also lead to better infrastructure design and retrofit choices, research has focused on techniques to identify the most important interventions and most beneficial choices. A basic and descriptive framework dealing with resilience of civil engineering structures exists.

Contributing experts also suggested many areas for further research. For example, noting that research has addressed the fields of resilience and sustainability through different perspectives, and contributing experts have suggested that the two concepts have to be united since infrastructures have to fulfil requirements of both fields at the same time. Other areas for further research suggested by contributing experts include: the apparent trade-off between rapid recovery strategies after a disaster and the need for improving long-term resilience; the development of

quantitative measures to describe the relationship between structural design, resilience and sustainable development in model-based approaches; the development of multi-layer protection systems; and further research on the interrelations between different kinds of infrastructures. Similarly, more systematic approaches need to be developed to support vulnerable countries in assessing and adapting to the impacts of climate change on their critical transport infrastructure such as ports and airports.^{88, 89}

The governance of infrastructure also influences the resilience and vulnerability of society to disasters; participatory governance and pro-actively informing citizens supports their ability to cope with disasters.⁹⁰ The relationship between the private and public sectors in providing resilient infrastructure is also an area that requires additional research. Specific topics identified include the relationship of different approaches to public-private partnerships (PPP) and the governance of critical infrastructure, and the different ways in which the public sector could provide incentives to increase resilience of private sector-provided infrastructure.

Relatively less developed is the research on how the quality, design, distribution and operation of infrastructure affect people's resilience through their effect on people's access to goods, services and job opportunities. A pattern in this area of study is the focus on specific areas and case studies to try to identify and quantify the effects of infrastructure on the capacity of people to withstand and adapt to shocks.

Contributing experts noted that the location and concentration of basic service infrastructures such as water distribution systems, drainage systems, and paved roads is related to the vulnerability and resilience of certain areas to natural disasters. It is also acknowledged that there are large disparities in adequacy and quality of

basic infrastructure between the core area and peri-urban edge of mega urban regions, causing the latter to be more vulnerable than the former during extreme events.

Some research has focused on the impact on jobs of building and maintaining infrastructure, and experts gave examples of how maintenance of inland waterways infrastructure (i.e., locks, dams, channel dredging) supports local and regional economies, and how the construction of drought-related infrastructure creates jobs.

Suggested areas for additional research include sustainable urban design, and analyses of infrastructure connecting communities to broader trade networks and its effect on resilience at community and national scales.

2.1.3 Inequality and resilience

The research on the link from inequality to resilience focuses on social capital and the effect of inequality on social norms, interactions and networks, which are considered to influence the capacity of people to recover and adapt following a natural disaster or economic shock (Table 2-6). There is recognition that particular attention should be paid to vulnerable populations following natural disasters, in particular women, children and persons with disabilities, as they are the most severely affected. Also covered is inequality in access to resources and the potential impact of shortage and differences in costs and quality of basic services such as water in triggering conflicts between different groups. The research in this area also highlights the existence of poverty traps, in which inequalities have an impact on infrastructure policies and then on vulnerability and resilience.

Some of the areas that require further research suggested by contributing experts include the study of quantitative links between resilience and inequality, and how the quality

of social and political organization affects vulnerability and resilience.

2.2 Harnessing synergies and addressing trade-offs

This section highlights policy areas suggested by contributing experts to harness the synergies and address the trade-offs between the three areas of the nexus (infrastructure, inequality and resilience). Policies aiming at reducing inequalities in all its dimensions are considered to have positive effect in infrastructure provision and increasing resilience by, for example, increasing the likelihood of infrastructure investments that benefit vulnerable groups.⁹¹ Many policies and strategies to reduce inequality are illustrated in chapter 1 of this Report. This section focuses on the narrower set of policies related to infrastructure and their effects on inequality and resilience.

The discussion of interlinkages in the previous section highlighted that improvements in infrastructure, in terms of provision of basic services and facilitation of access to goods, services and job opportunities, in general increase the resilience of people to all kinds of shocks; however, its effect on inequality mainly depend on where infrastructure is placed and who it serves. Reflecting this, contributing experts recommended that infrastructure policy should focus both on efficiency and on equity goals. In that respect, there is the view that an important policy component is the principle of geographic equity – that is, 'no place left behind', to correct the perceived disparities in the provision of basic services infrastructure in rural and peri-urban areas while public resources are concentrated in upgrading core areas. There is the recognition that urbanization in developing countries is rising fast⁹² and, therefore, policies should be

Table 2-6: Important interlinkages from inequality to resilience

Inequality → resilience		
Interlinkages	Illustrative research	Areas for further research suggested by experts
<p>Inequality of opportunity and discrimination affects social norms, interactions and networks, which have an effect on people's resilience</p> <p><i>Examples:</i></p> <ul style="list-style-type: none"> • Women and persons with disabilities are often disproportionately affected by natural disasters • Particular attention should be paid to vulnerable populations following natural disasters, as they are the most severely affected. • Analysis of child deaths in developing countries suggests that while boys and girls benefit equally from positive shocks in per capita GDP, negative shocks are much more harmful to girls than to boys. 	<ul style="list-style-type: none"> • Analysis of the role of social capital in building resilience for post-disaster recovery.⁹³ • Studies using social capital lens to assess adaptive capacity.⁹⁴ • Analysis of determinants of urban resilience.⁹⁵ • Role of social networks and civil society in coping with the effects of large natural disasters.⁹⁶ • Analysis of social resilience to the threat of water scarcity.⁹⁷ • Analysis of social resilience as is the capacity of social groups and communities to recover from, or respond positively to, crises.⁹⁸ 	<ul style="list-style-type: none"> • Personal and interpersonal connections with wider urban and national trends • Links between resilience and inequality quantitatively, especially at broad scales is open for research and would have a broad audience. • Connections of scale between local and urban processes and regional and national pressures; how the quality of social and political organization affects vulnerability and resilience; the complex interconnections between state reform and the growth of vulnerability and resilience.

Source: Authors, based on inputs by experts and literature review.

in place for the development of inclusive and sustainable infrastructure in urban areas.

In terms of synergies between infrastructure and resilience, contributing experts highlighted three key areas of policy intervention. First, there is a need to make infrastructure resilient to disasters by integrating disaster risk reduction into all phases of the infrastructure life cycle through regulation, norms and standards, urban planning, building codes, etc. Second, to reduce the risk of failure of critical infrastructure such as transport, energy, and telecommunications and its negative social and economic impact, experts highlighted the importance of policy directives on the security and resilience of these infrastructure.⁹⁹ Damages to infrastructure sometimes are unavoidable and appropriate recovery plans should prioritize infrastructure components that are most critical for affected communities. Third, infrastructure becomes more resilient when funding mechanisms and incentives to reduce risk are in place, for example, through the adoption of resilient-based requirements in the tendering and contracting process.

Contributing experts also noted the need to further disaggregate the analysis between rural and urban contexts to be able to provide more specific policy recommendations. For instance, for rural areas infrastructure investments are essential to connect individuals to livelihoods and opportunities for rising out of poverty. Conversely, urban areas provide easier connectivity due to concentration, but in many cases fragmented governance structures, congestion, and higher incidence of poverty in inadequately serviced and disadvantaged urban informal settlements and peri-urban areas require concerted efforts in order to achieve balanced development. The next sections take a look at the different challenges faced by urban and rural areas when addressing the interlinkages. It aims at summarizing a variety of actionable interventions highlighted by the contributors to this chapter to give a flavour of potential tools for policy makers dealing with these interlinked issues.

2.2.1 Infrastructure – inequality – resilience in rural areas

Lack of infrastructure investment in rural areas has received much attention more recently. Such investments may help people get out of the marginalization spiral, if properly designed and implemented. However, investment risks to disproportionately benefit the upper socio-economic strata if the needs of the marginalized groups are not duly taken into account.¹⁰⁰

Also, conventional cost-benefit analyses based on rural road appraisal models often fail to justify investment costs, as the traffic levels are normally too low to show a net discounted benefit.¹⁰¹ Wider economic and social benefits are generally ignored and insufficient attention is

paid to the value of time for different groups. Some studies propose ways in which the social costs and benefits of rural roads can be better measured and built into road appraisal programs.¹⁰² However, these studies have not yet led to mainstreaming pro-poor (and pro-marginalized groups) social measurements into conventional rural road assessments. This is mainly due to the challenges of identifying and measuring consistent and robust statistics, and the considerable differences in perceptions and weightings given by local communities and national authorities.¹⁰³

Despite the challenges, many countries have found important to invest in rural transportation. The government of India has made a policy decision to connect all villages with more than 500 inhabitants (250 inhabitants in the remoter areas) to an all-weather road. China also aims to connect all 'administrative villages' to all-weather roads. New designs of trail bridges and footpath construction have been developed and tested by local communities.¹⁰⁴ Some countries, such as Lesotho and Nepal, even have specific units responsible for installing and maintaining rural footbridges. A rural transport project in Peru rehabilitated and maintained 7,000 km of trails, primarily used by women and children.¹⁰⁵

An additional pro-poor transmission channel can be secured by associated labour-based programs in these types of infrastructure projects. Many guidelines are available to help planners and engineers adopt labour-based approaches,¹⁰⁶ and ILO, for example, has prepared guidelines for adapting tools so that people with disabilities can be included in these programs.¹⁰⁷

Quite often transport planning and decision making tend to be conducted as a technocratic process with minimal information released to the public until construction begins. Infrastructure projects would benefit from participatory processes that involve local communities and their various segments such as women, youth, minorities and other constituencies. A participatory approach would increase the likelihood that the needs of those further behind are prioritized. Participatory planning tools such as the Sustainable Transport Appraisal Rating (STAR) and the Integrated Rural Accessibility Planning (IRAP) allow for consulting with local communities when preparing investment plans based on multi-dimensional measurement tool that includes economic, poverty and social, environmental and sustainability risk criteria.¹⁰⁸

2.2.2 Infrastructure – inequality – resilience in urban areas

Compared to rural areas, cities have different challenges to address when dealing with interlinkages in the nexus. Cities tend to have governance structures that are fragmented both horizontally and vertically, making it difficult to

coordinate the design, implementation and management of infrastructure.¹⁰⁹ Cities, particularly in developing countries, also face particular challenges in relation to funding infrastructure as they show a tendency to collect limited own-source revenues and privilege the funding of recurrent costs, such as salaries, over capital expenditure. As a result, the capitals of many developing countries (many of which are LDCs) rank at the bottom of global indexes of liveability,¹¹⁰ which report an increasing burden on people's perceptions in terms of socio-economic opportunities and equality of access.¹¹¹

In 2014, there were estimated 900 million passenger cars and light duty vehicles in developing countries. This is expected to increase to nearly 1.6 billion vehicles by 2035. Mexico City's car population is increasing twice as fast as its population, while India's private vehicle population is increasing three times as fast.¹¹² Congestion has been an increasing problem. Financial costs of efficient public transport development are often too high for many cities in developing countries¹¹³. Due to this financial and capacity constraint, informal transport dominates service provision in most developing countries.

In urban areas, many poor can benefit from infrastructure investment and maintenance that focus on affordable public transport and in facilitating the use of less expensive means of transport such as bicycles and motorcycles. Since the poor live disproportionately in peri-urban slums and since these areas are the least served and connected, the poor tend to be disproportionately affected by the inadequate status of infrastructure. Indeed, they are disproportionately affected by the time spent on getting access to a given service – be it transport, or securing water, electricity, fire, etc. And since women have multiple daily journey patterns, including taking children to school, going to work, going to healthcare facilities, going shopping, etc., they are disproportionately affected by the lack of services and investment in these peri-urban areas. In addition, these are areas where pollution levels tend to be most concentrated and reach the highest levels.

Labour-intensive road construction programs have been carried out in few urban projects in which the objective was to provide employment for the poor. Examples include the South African Expanded Public Works Programme (EPWP) and the Bangladesh Local Government Engineering Department (LGED), as well as several small urban community-based employment programs in Africa, such as storm water drainage and footpaths in Kampala and Dar es Salaam, roads and drains in Lusaka, bicycle lanes in Kisumu (Kenya) and road rehabilitation in Nairobi.¹¹⁴

The urban planning process in many cases involves undertaking surveys and collecting data on travel patterns.¹¹⁵ To this extent, data need to be collected from

different groups in society, including poor people and slum dwellers. However, often lacking is a comprehensive dialogue with different groups on the key urban transport choices. To alleviate this, urban planning involve civil society organizations more systematically in their decision-making process. For example, in a well-known case in Mumbai, India, CSOs saw that organized groups of slum dwellers were able to reach an agreement with the Railroad Transport Authority and municipal authorities to relocate and resettle several thousand households living in slum settlements located alongside railway tracks.¹¹⁶

Several policy brief contributions to this Report have focused on emerging issues in urban areas related to inequality, vulnerability to the effects of climate change, and insufficient infrastructure systems. A summary of the key messages of these contributions is presented in Box 2-2.

2.3 Conclusions

This chapter aimed to illustrate the importance of adopting an integrated approach towards sustainable development, by highlighting some of the main interlinkages between infrastructure, inequality and resilience. Among the possible interlinkages in the nexus, the areas that are usually covered by scientific research are the links between infrastructure and inequality, and how people's resilience is affected separately by infrastructure resilience and by inequality. The links that are not covered are those from resilience to inequality and from resilience to infrastructure. These are relevant linkages and further research in this area is needed to uncover important synergies and trade-offs.

In terms of policy areas related to the nexus, focus on both efficiency and equity goals is needed to harness the synergies between infrastructure, inequality and resilience. An important policy component is geographic equity in the provision of basic infrastructure. Regulation and incentive mechanisms need also to be in place to integrate disaster risk reduction into all phases of the infrastructure life cycle, and to ensure the resilience of critical infrastructure to natural disasters. Contributing experts have also noted the need to further disaggregate the analysis between rural and urban contexts to be able to provide more specific policy recommendations.

Further cross-disciplinary collaboration and engagement between researchers, practitioners, decision makers and other stakeholders could be a way of achieving the mutual learning and transfer of information that would enable scientific knowledge to be transformed into practical strategies to harness the synergies and address the trade-offs between the three areas of the nexus.

Box 2-2: Emerging issues in the urban context related to the infrastructure, inequality and resilience nexus

Holistic, large-scale and integrated changes are needed to make cities more sustainable and resilient—to build capacity for absorbing future shocks and stresses to social, economic, and technological systems, and to develop infrastructure through processes of evolution and adaptation. Many cities are undergoing urban sustainability transformations, which aim to integrate resource efficiency, resilience and quality of life, and address the social and political challenges inherent in transformative change.¹¹⁷ Green infrastructure approaches to urban planning maximize the functions of the natural environment in urban areas while simultaneously protecting it, and have multiple ecological and social benefits, including for sustainable water management, CO₂ storage and removal, reduced energy use in buildings, air quality improvement, and human health and wellbeing.¹¹⁸

In areas where the process of industrialization is still in the early stages, it is important to promote air pollution mitigation technologies such as catalysts, filters and renewable energy replacements to make cities safer, sustainable, and more resilient.¹¹⁹ Successfully integrating climate change mitigation measures in cities will require disaggregated data to better inform policies and planning in areas characterized by high levels of urbanization and poverty and by low levels of infrastructure provision (e.g. river delta regions).¹²⁰

Implementing clean and affordable modern technologies inside homes can reduce death and disease rates due to indoor air pollution, increase women's empowerment, and ensure a healthy learning environment for children. Bottom-up interventions such as "E-VOIDs", which upgrade the infrastructure of high-density slums to allow for better lighting and ventilation, are being designed and implemented by poor communities in densely packed urban areas.¹²¹ Innovative financing such as Social Impact Bonds (SIBs) that reward investors with financial return aligned to positive social impacts (e.g. investing in safer road infrastructure to reduce road traffic deaths),¹²² and green bonds that link investment to reductions in carbon emissions (e.g. through low emissions public vehicles or investments in walking and cycling infrastructure) are being promoted through efforts to achieve more sustainable and resilient cities.

Source: Science-policy briefs submitted for the GSDR 2016.

Endnotes

- 1 In many countries the private sector largely owns and operate infrastructure.
- 2 Estimates from the Global Tracking Framework 2015 led by the World Bank and International Energy Agency (IEA), in coordination with the Energy Sector Management Assistance Program (ESMAP) and 20 other partner agencies. Information available from: <http://trackingenergy4all.worldbank.org/>
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- 11 The IPCC defines resilience as “the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a potentially hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions.” (see Lavell, A., M. Oppenheimer, C. Diop, J. Hess, R. Lempert, J. Li, R. Muir-Wood, and S. Myeong, 2012: Climate change: new dimensions in disaster risk, exposure, vulnerability, and resilience. In: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 25-64. Lau, S.H.P. and Sin, C.Y. (1997), Public Infrastructure and Economic Growth: Time Series Properties and Evidence. *Economic Record*, 73, 125-135, Australia).
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- 13 The World Economic and Social Survey 2016 examines and presents relevant lessons on these links from resilience to inequality and to infrastructure.
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- 15 Overall, the literature finds positive effects of investment in infrastructure development on economic output and growth. For examples see Aschauer, D., (1989). Is Public Expenditure Productive? *Journal of Monetary Economics* 23, 177-200; Munnell, Alicia H. (1992), Policy Watch: Infrastructure Investment and Economic Growth. *The Journal of Economic Perspectives* Volume 6 No. 4, pp. 189-98; Lau, S.H.P. and Sin, C.Y. (1997), Public Infrastructure and Economic Growth: Time Series Properties and Evidence. *Economic Record*, 73, 125-135, Australia; Walsh J.P, C. Park, and J. Yu (2011), Financing Infrastructure in India: Macroeconomic Lessons and Emerging Markets Case Studies. IMF Working Paper/181, Washington, D.C; Mohommad, A. (2010), Manufacturing Sector Productivity in India: All-India Trends, Regional Patterns, and Network Externalities from Infrastructure on Regional Growth. Ph.D Dissertation, University of Maryland), although with disparities across countries (see Canning, D. and Pedroni P. (2008), Infrastructure, long-run economic growth and causality tests for cointegrated panels. *The Manchester School, University of Manchester*, Volume 76 (5), 504-527) and types of infrastructure. In particular, electricity and connectivity infrastructure such as roads and telecommunications have been found to have a substantial positive productivity effect, which contributes to economic growth (For examples see Calderón, C. and Servén, L. (2003), The Output Cost of Latin America's Infrastructure Gap, in Easterly, W., Servén, L., eds., *The Limits of Stabilization: Infrastructure, Public Deficits, and Growth in Latin America*. Stanford University Press and the World Bank, USA; Estache, A., B. Speciale, and D. Veredas, (2006). –How Much Does Infrastructure Matter to Growth in Sub-Saharan Africa?. The World Bank, Washington, D.C., processed; Roller L.H., Waverman L. (2001), Telecommunications Infrastructure and Economic Development: a simultaneous Approach. *The American Economic Review*, 91 (4), pp. 909-23; and Poulos, C., S.K. Pattanaya, and K. Jones, (2006). A Guide to Water and Sanitation Sector Impact Evaluations, *Doing Impact Evaluation #4*, The World Bank).
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- 19 For examples see Bajar, S. & Meenakshi, R 2015, 'The Impact of Infrastructure Provisioning on Inequality: Evidence from India', *GLU Working Papers*, 33-37, p. 1, Publisher Provided Full Text Searching File, EBSCOhost, viewed 28 March 2016; and Balisacan, A. M., and E. M. Pernia, 2002. *Probing Beneath Cross-National Averages: Poverty, Inequality, and Growth in the Philippines*. ERD Working Paper Series No. 7, Economics and Research Department, Asian Development Bank, Manila; Songco, 2002.
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- 56 Some examples of the literature are the following: Review of 27 studies linking road access to agriculture and summary of how the construction of rural roads had led to increased agricultural production (Knox J, Daccache A and Hess T, 2013. *Systematic Review: What is the Impact of Infrastructural Investments in Roads, Electricity and Irrigation on Agricultural Productivity?* Collaboration for Environmental Evidence, Bangor, UK). Surveyed Ugandan firms and shows that, faced with unavailable and unpredictable services, many firms invest in substitutes such as electricity generators and significantly reduce productive private investment (Reinikka, R. and J. Svensson, 1999, *How Inadequate Provision of Public Infrastructure and Services Affects Private Investment*, The World Bank, Policy Research Working Paper Series: 2262). Their findings are similar to those from investment climate assessments, such as (Anas A., Lee K. and Murray M., 1996, *Infrastructure Bottlenecks, Private Provision and Industrial Productivity*, World Bank Policy Research Working Paper 1603.) and (Lee K. S., A. Anas and G.-T. Oh., 1996, *Cost of infrastructure deficiencies in Manufacturing in Indonesia, Nigeria, and Thailand*, World Bank Policy Research Working Paper 1604) on Indonesia, Nigeria and Thailand, and (Alby P. and Straub S., 2007, *Investment Climate Assessment and Infrastructure: Evidence from 8 Latin American Countries*, mimeo World Bank) on eight Latin American countries. Escobal, J. and Ponce, C., 2002, (The benefits of rural roads: enhancing income opportunities for the rural poor, *GRADE Working Paper 40*. Grupo de Análisis para el Desarrollo (GRADE), Lima, Peru. 56p. ISBN: 9972-615-25-1) also reviewed 25 studies relating to rural transport in various countries and found that investment in this type of infrastructure enhanced agricultural production, employment, living standards and poverty reduction. Lebo and Schelling (Design and appraisal of rural transport infrastructure: ensuring basic access for rural communities. Technical Paper 496, World Bank, Washington DC, USA, 2001) showed that new roads are correlated with lower input prices and freight costs in India, with increasing crop outputs in Ethiopia (Dercon S, Gilligan D O, Hoddinott J and Tassew Woldehanna, 2009. The impact of agricultural extension and roads on poverty and consumption growth in fifteen Ethiopian villages. *American Journal of Agricultural Economics*, 91 (4): 1007-1021.) and increasing cultivated farm areas in Nicaragua (Orbicon and Goss Gilroy, 2010. *Impact evaluation of Danida support to rural transport infrastructure in Nicaragua*. Evaluation Department, Ministry of Foreign Affairs of Denmark, Copenhagen. 128p.). In sub-Saharan Africa, Dorosh, Wang, You and Schmidt (Crop Production and Road Connectivity in Sub-Saharan Africa: A Spatial Analysis. Policy Research Working Paper 5385, World Bank, Washington DC, USA, 2010) concluded that agricultural production in areas more than eight hours travel time from a town of 100,000 people was only at 5% of its potential, compared with 45% of its potential in areas less than four hours travel time. The lack of rural roads and the poor quality of road infrastructure has also been cited as a major constraint to agricultural production in East Africa (Salami A, Kamara A and Brixiova Z, 2010, *Smallholder agriculture in East Africa: trends, constraints and opportunities*. AfDB Working Paper No. 105, African Development Bank, Tunisia).
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PERSPECTIVES OF SCIENTISTS ON TECHNOLOGY AND THE SDGs

3.1 Technology and the SDGs

In view of its ambition and the complexity of the challenges it addresses, implementing Agenda 2030 is a daunting task. Scientists and many people see technology as a major factor that can help to meet the Sustainable Development Goals. Technology can help build on synergies among the goals, realize possible multiple benefits as well as avoid barriers and conflicts on the challenging road toward SDGs. Against this background, the present chapter presents a range of perspectives of scientists on the most promising actions or policy elements for optimal leveraging of technology for the SDGs and “leaving no-one behind”, as well as on which technologies will be most crucial until 2030 (see Box 3-1). It aims to inform policy makers in this early phase of implementation.

Box 3-1: Methodology

The present chapter is a synthesis by UN staff of inputs from 61 scientists and experts in April and May 2016 to two specific questions: *There are many technology challenges for achieving the SDGs and lots of expectations for technology solutions. Against this background: (1) What are the most promising actions or policy elements for optimal leveraging of technology for the SDGs and “leaving no-one behind”? (2) Which technologies and what level of their performance and deployment will be most crucial until 2030?* It is important to note that present chapter does not present a consensus view of contributing scientists, but presents the range of views submitted.

The two questions were addressed at several hundred eminent scientists and experts from a wide range of disciplines. The request for inputs was also sent to scientific members of the Technology Facilitation Mechanism's 10-Member Group, UNFCCC TEC members, previous contributors to the Global Sustainable Development Report, especially those who had submitted science-policy briefs, as well as participants in the UN expert group meeting on emerging issues which was held in April 2016. Requests were also sent to expert staff in UN entities and major scientific organizations and programmes, such as the International Council for Science (ICSU), Future Earth, and the Sustainable Development Solutions Network. Recipients were encouraged to further share the call with relevant colleagues. Notably, one of the responses was from an interdisciplinary team of seven academics active in the Harvard Project on Innovation and Access to Technology for Sustainable Development which conducted 18 original case studies in the water, energy, health, agriculture and manufacturing sectors and synthesized literatures across a range of fields including innovation systems, economics, science and technology studies, law, engineering, international relations and complex systems.^{1,2}

The contributing scientists have affiliations with research institutions in 20 countries: Australia, Austria, Brazil, Canada, Chile, China, Ethiopia, France, Germany, India, Ireland, Japan, Jordan, Mali, Mauritius, the Netherlands, Norway, South Africa, the United Kingdom, and the United States of America (see acknowledgments). They represent a wide range of sustainability science disciplines.

In addition, the following data sources were considered: 58 technology-related science-policy briefs³ prepared by 97 scientists in support of the GSDR and the HLPF that had been submitted by individual scientists since 2014; an online survey in early 2016, whereby scientists could simply list what they considered the most important emerging technologies; and a follow-up UN expert group meeting on emerging issues that was organised in New York from 5 to 6 April 2016 (see also chapter 5).

Source: Authors.

3.1.1 Technology – a solution and a problem

Technology has greatly shaped society, economy and environment. Indeed, technology is a double edged tool^{4, 5} – while technology progress has been a solution to many ills and problems, it has also added ever new challenges.^{6, 7}

Socio-economic development is inextricably linked to technology change, as technology, society and institutions co-evolve. Technology change can be a source of conflict, as well as a tool for social inclusion and greater cooperation. For example, ICTs have allowed huge advances in this respect, e.g., in health, education, transport and communications, but they have led to security and privacy challenges. To varying degrees, all technologies consume resources, use land and pollute air, water and the atmosphere. While increasing eco-efficiency of technology use has reduced the amounts of resources consumed and pollution produced per unit of output over the long run, absolute amounts of consumption and pollution have continued to increase unsustainably. Against this background, governments have long called for concerted actions to accelerate change towards more sustainable technology. Many technology optimists believe such acceleration is essential and call it the technology innovation imperative.⁸

It should also be noted that technology change itself is often not neutral. Instead, it is often biased toward capital

and skilled labour and hence has significant distributional effects leading to increased inequality.⁹ Technologies invented or adapted in developing countries are likely to be more suitable for use in other developing countries.^{10, 11}

3.1.2 Technology dimension of the SDGs

The 2030 Agenda recognizes the importance of technology for the achievement of the SDGs. Technology is not only captured in SDG17 as a key “means of implementation”. Among the 169 targets, 14 targets explicitly refer to “technology” and another 34 targets relate to issues that are most often largely discussed in technology terms (Table 3-1). There are also certain technology dimensions to the other remaining 121 targets, in which case, however, technology is only one of many means for their implementation. Table 1 categorizes those 48 targets that are most closely related to technology along three targets: (a) significant overall technology performance improvement; (b) universal access to sustainable technology; and (c) global effective innovation system for sustainable development. Table 3-1 is based on interdisciplinary expert assessment. Individual views as to which targets are technology-related necessarily differ. For example, energy engineers tended to see large technological components in the target to provide universal access to affordable, reliable and modern energy services, whereas political scientists or anthropologists tended to emphasize the non-technological elements.¹²

Table 3-1 thus translates the complex list of SDG targets into a form that can readily be related to existing scientific literature and assessments (see also their coverage in the Global Sustainable Development Reports 2014 and 2015). Technology-related targets have also been proposed in the scientific literature. They are usually much more quantitative than the agreed SDG targets.

The remaining 121 targets – which are not included in Table 3-1 – fall primarily into the equity and institutional categories.

Hence, while the creators of the SDGs overwhelmingly focused on the objective to “leave no-one behind” in all its dimensions, when it came to technology, they included a significant number of overall technology performance targets. This is very much in line with scientific findings that point to a need for making simultaneous progress in equity, overall technology performance and institutions, as well as in both radical and incremental technology change.

Table 3-1: Selected SDG targets that most closely relate to technology

Principle & overall goals	Technology-related SDG targets (48 of 169 targets)
Significant overall technology performance improvement	<p>General technology performance targets for 2030:</p> <p>8.4 Improve progressively... global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation...</p> <p>8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation....</p> <p>9.4 ...upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes....</p>
19 targets	<p>Issue-specific, quantitative technology performance targets for 2030:</p> <p>2.3 ...double the agricultural productivity of small-scale food producers....</p> <p>3.3 ...end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases</p> <p>3.6 ...halve the number of global deaths and injuries from road traffic accidents</p> <p>6.3 ...halving the proportion of untreated wastewater</p> <p>7.3 ...double the global rate of improvement in energy efficiency</p> <p>12.3 ...halve per capita global food waste at the retail and consumer levels...</p> <p>Issue-specific, qualitative technology performance targets for 2030:</p> <p>3.9 ...substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination</p> <p>6.3 ...improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials.... and substantially increasing recycling and safe reuse globally</p> <p>6.4 ...substantially increase water-use efficiency across all sectors...</p> <p>7.2 ...increase substantially the share of renewable energy in the global energy mix</p> <p>7.b ...expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries...</p> <p>12.3 ...reduce food losses along production and supply chains, including post-harvest losses</p> <p>12.5 ...substantially reduce waste generation through prevention, reduction, recycling and reuse</p> <p>14.1 ...prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution (by 2025)</p> <p>14.3 Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels</p> <p>2.5. ...maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species (by 2020)</p>
Universal access to sustainable technology	<p>Access to basic services by 2030:</p> <p>1.4. ...ensure that all men and women have... access to basic services...and...appropriate new technology...</p> <p>6.1 ...achieve universal and equitable access to safe and affordable drinking water for all</p> <p>6.2 ...achieve access to adequate and equitable sanitation and hygiene for all and end open defecation....</p> <p>7.1 ...ensure universal access to affordable, reliable and modern energy services</p> <p>11.1 ...ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums</p> <p>11.2 ...provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety...</p> <p>Access to technology:</p> <p>3.bprovide access to affordable essential medicines and vaccines....</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure,, with a focus on affordable and equitable access for all</p> <p>9.c Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020</p> <p>16.10 Ensure public access to information and protect fundamental freedoms...</p> <p>Technology use:</p> <p>5.b Enhance the use of enabling technology, in particular ICT, to promote the empowerment of women</p> <p>11.2 ...expanding public transport</p>
12 targets	

Table 3-1: (continued)

Principle & overall goals	Technology-related SDG targets (48 of 169 targets)
Global effective innovation system for sustainable development 17 targets	<p>Research, development and demonstration: 3.b Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries... 9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending 9.b Support domestic technology development, research and innovation in developing countries... 14.a Increase scientific knowledge, develop research capacity and transfer marine technology...</p> <p>Technology transfer and diffusion: 17.7 Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed 17.8 Fully operationalize the technology bank and science, technology and innovation capacity-building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology</p> <p>Higher education and STI capacity building: 4.b By 2020, substantially expand globally the number of scholarships available to developing countries.... for enrolment in higher education, including....information and communications technology, technical, engineering and scientific programmes... 13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning</p> <p>STI policy environment and market incentives: 8.3 Promote development-oriented policies that support ... entrepreneurship, creativity and innovation... 9.b ...ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities 12.c Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts...</p> <p>International cooperation on STI capacity, technology access and transfer: 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... 6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies. 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 9.a Facilitate sustainable and resilient infrastructure development in developing countries through enhanced... technological.... support to African countries, least developed countries, landlocked developing countries and small island developing States 12.a Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production 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 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</p>

Source: Authors, based on interdisciplinary expert assessment.

3.2 Scientists' perspectives on policy and actions for leveraging technology for the SDGs

Against this backdrop, much can be learnt from a synthesis of the most important current perspectives of scientists.^{13,14,15}

In the survey conducted for this report, scientists were asked to identify the "the most promising actions or policy elements for optimal leveraging of technology for the SDGs and 'leaving no-one behind'". (see Box 3-1).

In the following, the selected proposals of these scientists are summarized. (Table 3-2) They do not necessarily present a consensus of the contributors, but illustrate the range of views and perspectives. More detailed results are reported in a background paper for this chapter on "Perspectives of scientists on technology and the SDGs"¹⁶ in which scientists' responses are presented along disciplinary lines.

Table 3-2: Selected proposals by contributing scientists for optimal leveraging of technology for the SDGs and leaving no-one behind

Theme	Summary proposals	Action level
Strengthening national systems of innovation to accelerate technology progress	<ul style="list-style-type: none"> • Systematically strengthen national systems of innovation, especially in developing countries. • Incremental and radical technology and infrastructure performance improvements – all are needed. • Barriers to technology deployment and diffusion in developing countries to be removed and R&D investments to be increased. • Coherent and comprehensive techno-economic policies are needed. • Science, technology, and innovation (STI) literacy need to be strengthened in every country to create knowledge-based, innovative societies that utilize scientific evidence to help inform policy. • Learning across spheres of practice and implementing lessons from existing technology-related initiatives and from “experiments” of new SDG-related technologies in specific communities. 	National
Plans, roadmaps and integrated assessment	<ul style="list-style-type: none"> • National and international action plans and technology roadmaps for achieving the SDGs individually and together. • Science roadmaps, technology roadmaps and R&D roadmaps to agree on priority actions of the science and engineering communities. • Technology investments need to be significantly increased. • Share information and advice among countries on policies, actions, and partnerships. • Communication, education and public awareness raising are essential, especially among consumers. • Systems thinking and technologies for a circular economy. • Integrated assessment models can be useful to design sustainable development policies. • Countries to explore their own desired paths of economic diversification based on identification of promising technological trajectories and new industries. Industrial policies. 	National and global
Putting technology at the service of inclusion	<ul style="list-style-type: none"> • Access to affordable, modern technology for everyone, especially in developing countries. • Inclusive innovation policies to promote equity. • Technology assessment and foresight to understand potential implications of new technologies and guide policy. • Ecosystem approach to policy, in order to address technology gaps continually arising with new technologies. • Taking into account the interests of underserved populations throughout the innovation process. • Promote access to and use of assistive technology for people with disabilities. • On-the-ground solutions and technological innovations to be considered a core component of livelihood strategies. • Leverage the social technology of sharing in urban slums. • Intervention research drawing on cognitive science, psychology, behavioural economics, and anthropology. • Explicitly consider informal cultural norms and the nexus to formal rules when assessing technology needs/gaps. 	Global, national and local
Building institutions that support sustainable technology progress	<ul style="list-style-type: none"> • Institutions need to be reformed to re-orient innovation systems towards sustainable development. • Support for R&D and incentives for deployment of cheaper technologies with systemic benefits, including off-grid electricity systems, e-mobility and novel antimicrobial medicines. • Promote urban innovation units, living labs, open science, and science parks, to harness localised, inclusive innovations. • Re-defining megacities' functions through legislation and balanced distribution of public resources. • Institutions to promote development of low cost local technology solutions based on community knowledge. • Better data need to be collected, openly shared and analysed. • Partnerships at the city and national levels could bring together and share disaggregated data. • New tools and scientific innovations for data collection and analysis. Big data to monitor and promote the SDGs. 	Global, national and city

Source: Authors, based on contributing scientists' proposals.

Responding scientists typically proposed policies and actions that encompassed several themes and types of actions, not just one or two. They tended to highlight also policies and actions that go far beyond their disciplinary special expertise, which illustrates their integrated systems views. This runs counter to the high level of specialization that exists in modern science. This result may not be representative of science as a whole, but is likely due to a selection bias arising from inviting scientists interested in aspects of sustainability science (see Box 3-1 on methodology).

3.2.1 Strengthening national systems of innovation to accelerate technology progress

National systems of innovation need to be strengthened, especially in developing countries. National innovation systems comprise many institutions and the cooperative actions of financiers, law makers, business people, institutional checks and balances, and researchers developing new technologies.¹⁷ These 'systems of innovation' play a key role in enabling the country to manage the process of technology change, which ultimately will be of use across many areas of the SDGs.^{18,19} Leveraging institutional innovation and changing consumer behaviour may be equally important as progress in technology performance.²⁰ In this view, interdependencies are considered between different technologies and the various stages of technology life cycles. It finds that investments are needed in both new and old technology systems, in both components at the technology frontier and those that promote technology access to all, as well as exploratory and even in "crazy" ideas and innovations.²¹ Prioritising one at the expense of the other is counterproductive for the effective functioning of the system, as experience has shown.

Incremental and radical technology and infrastructure performance improvements – all are needed. Accelerated technology change and a deep transformation are required for the achievement of the SDGs. Incremental gradual technology and institutional improvements are needed as are radical, Schumpeterian "gales of creative destruction" of materials and emissions intensive human activities. Even in the case of successful radical new solutions, incremental improvements after initial market deployment are essential. To ensure a high quality of life, the transformation will need to encompass both the supply side and the end-use changes.²² This is a major challenge, as some economic sectors might experience disinvestment, leading to winners and losers. Consumption needs to be oriented toward high efficiencies - e.g. through circular processes that reuse waste products as resources - and low energy, water and land use intensities.²³

Infrastructures are essential for technological change, as they influence industries' capacity to maintain and expand their technological knowledge base.²⁴ In particular, Governments need to provide the basic and essential technological infrastructures in the economy, including electricity supply, Internet and broadband connectivity, computer hardware, software, and technical skills for support and maintenance,²⁵ all of which are essential for the knowledge economy.^{26, 27, 28} Similarly, transport infrastructure, good schools and health centers are important. Infrastructures have long diffusion times and require large upfront investments, and thus political will, long-term commitment, coherent policies and the rule of law are essential.^{29,30} One example that illustrates the need for a nuanced perspective on technology and infrastructure is a recent programme to put broadband in every hospital in Ethiopia which was cancelled when it became evident that hospitals had more pressing concerns like keeping the lights on or finding money for diesel for a generator. A nuanced view was needed on how to properly sequence development and identify opportunities for leapfrogging, which do exist, but are probably overestimated.³¹

Granular, smaller-scale technologies with many units (e.g., mobile phones) tend to diffuse fast, but also require infrastructures and regulation just like the lumpier and larger-scale counterparts. All require human capacity, stable investment environments and institutional arrangements. *Granular technologies* often show rapid technological learning resulting in lower costs which makes them *useful solutions in rapidly growing parts of the developing world*.

Many technologies already exist, but their *deployment and diffusion in developing countries is lagging behind due to many technical, economic, institutional, legal and behavioral barriers*.^{32, 33} Examples include IPR issues, private sector capacity, mismatched needs, trade tariffs, and limited access to trusted information, knowledge and capital.³⁴ At the same time, new and advanced technologies need to be developed, continuously improved, shared, and deployed, which requires R&D at all stages, from basic research to development and deployment and in an integrated manner across stages. Global private and public R&D investments reached US\$1.6 trillion per year (or 2 per cent of GDP) in 2014.³⁵ However, 78 per cent of these investments were in USA, China, Japan and Europe. In contrast, R&D levels in most developing countries remained much lower than 2 per cent of GDP.³⁶

Coherent and comprehensive techno-economic policies are needed. Externalities should be internalized by charging for pollution and emissions. To move towards full internalisation of externalities will take considerable time. In particular, least developed countries would not be expected to achieve full internalisation in the short- to medium-term, and OECD

countries could provide them with stepped-up finance and technology transfer for development and adaptation, in order to support the transition process. Governments should avoid “picking of winners”, but rather create a level-playing field for all low-polluting technologies on a life-cycle basis. Resources could be conserved by the introduction and incentives to switch to a circular economy (including 3R – reduce, reuse, recycle). Abolishment of tariffs on trade or transfer of environment friendly technologies is one example of how adoption of green technologies could be fostered. Systematic policies need to be instituted to shorten the time-to-market for produce from developing countries.³⁷

Science, technology, and innovation (STI) literacy need to be strengthened in every country to create knowledge-based, innovative societies that utilize scientific evidence to help inform policy. This requires wise investments in human capital including education at all levels, in fundamental and applied research and development, in infrastructure. Also needed are wise government policies to facilitate “bottom-up” innovation by entrepreneurs in private companies and universities. These policies would reduce corruption, permit freedom of inquiry, establish rule of law, expand participation by women, and expand private sector investment and trade – all of which will unleash the creativity of many people, create new jobs, and accelerate scientific and technical advances.³⁸ Policies to institute participation of scientists in national decision making and to establish technology transfer mechanisms could potentially enhance national innovation capacities and link research communities to economic sectors and society at large.³⁹ One example of the benefits of science-based information in support of policy making is climate adaptation technology for water management,⁴⁰ without which many people will suffer water shortages, lack safe water, increased water pollution, biodiversity reduction, and increased frequency and intensity of floods, droughts, and heat waves.^{41, 42}

There is a need to facilitate experiments of new SDG-related technologies in specific communities, to carry out social and scientific monitoring, to draw lessons in order to upscale with many small scale experiments and also with many sites on larger scale projects,⁴³ as well as to create trust with people involved making sure that the politicians and business people involved are not abusing the situation.⁴⁴

Measures are needed to regularize learning across spheres of practice to improve understanding of how to re-orient innovation systems⁴⁵ towards sustainable development. Developing targeted interventions requires an understanding of innovation systems and their socio-technical nature. Many potential lessons are already available.⁴⁶ Socio-technical characteristics – such as mundaneness, role of standards and certification, network externalities, and modularity

- can be used as heuristics to identify possible barriers to innovation that could emerge when selecting particular technologies or interventions. Actors with convening power should facilitate learning across disparate communities of practice. For example, they could organize conferences bringing together practitioners, policymakers, and scholars from more than one sector; they could fund comparative analyses drawing on more than one sector or location; and could teach students across disciplines to think broadly about technological innovation.

Learning and implementing lessons from existing technology-related initiatives is important. Scientists pointed out several examples. One example was Chile’s programmes on cluster development. Following an analysis which showed that only 15 per cent of researchers in Chile were engaged in applied research,⁴⁷ the government strengthened coordination between public and private sectors and academia. It commissioned studies on cluster development,⁴⁸ a strategic market study, an energy policy roadmap, and eventually developed a strategic solar industry programme in which a private public committee allocated resources for applied research. In the case of the mining industry cluster, road-mapping was added to general cluster analysis and foresight exercises carried out by industry.⁴⁹ Another example was systematic information on incorporating mobile technologies into community health practices (mHealth) in Rwanda which has enabled learning from existing practices.⁵⁰ Information on mobile phone ownership, user characteristics (such as age and education), and technology design enabled health care providers to engage directly with patients.^{51, 52} Another example is the creation of planted forests conservation units in the São Marcelo Park Forest in Brazil,⁵³ where technology was used to control good quality and humidity air which led to natural regeneration.^{54, 55, 56, 57}

3.2.2. Plans, roadmaps and integrated assessment

National and international action plans and roadmaps should be developed for achieving the SDGs individually and together. This should include participation from government, private companies, academia, and NGOs. Feedback is needed from the STI community on what is working and what not.⁵⁸ Technology roadmaps, particularly at national and global levels could provide insights on implementation and the available options.⁵⁹ Action plans should include a strong mobilization of financial resources for their implementation and evaluations of technology transfer requirements in all countries.⁶⁰

The science and engineering communities could develop science road maps for 10 to 20 years into the future, e.g., on key issues like geological assessment of carbon capture and storage (CCS) storage for which a global geophysical effort is needed. They could develop technology roadmaps

for most SDGs, in cooperation with engineering academies. They could *develop research and development roadmaps* which would include a budget, a structure and R&D partnerships for 5 to 10 years. The communities could also cooperate conducting science and technology training worldwide which could be a global effort across universities and supported by science and engineering academies.⁶¹

Information and advice has to be shared effectively among countries on policies, actions, and partnerships. This could be done through many venues, such as the multi-stakeholder STI Forum and on-line platform of the UN Technology Facilitation Mechanism,⁶² and through new communication technologies that can be utilized for maximizing STI contributions to the SDGs and for connecting innovators, developers, and investors of technologies with those who need solutions to their problems and challenges.⁶³

Systems thinking and technologies for a circular economy. A circular economy is one in which industrial systems are restorative and regenerative by intention and design.^{64,65,66,67} Creating a circular economy requires bringing together academia, the private sector, the public sector and civil society. More sustainable production schemes and innovation in the private sector are needed. For example, industrial symbiosis which establishes cooperation and synergies between two or more industries, often including non-industrial partners, can make a significant contribution to improved resource efficiency.⁶⁸ Systems thinking is essential to manage trade-offs, especially in the next between human health and wellbeing,⁶⁹ urbanisation, and ecosystem services,⁷⁰ or the water-energy-food-nexus.^{71,72,73}

Integrated assessment models can be useful to design sustainable development policies, as the SDGs are interlinked in complex and often subtle ways^{74,75,76} Actions to achieve progress in one SDG sector may enhance or diminish performance in other sectors.^{77,78} Integrated assessment models can serve as experimental platform for testing the effectiveness of proposed interventions for achieving the SDGs. They have illustrated the importance of integrated design of urban and rural mobility will be key, notably a well-functioning public transport infrastructure, new mobility options such as e-bike or e-cars, and in suitable areas biofuel supply chains. One example of such models is the Millennium Institute's iSDG model.^{79,80,81,82}

Countries need to explore their own desired paths of economic diversification based on identification of promising technological trajectories and new industries. Empirical evidence shows that development is associated with the shift of labour from low- to high-productivity and high-wage activities.⁸³ The changes in the composition of the economic system occurring during this process give rise to an increasing variety and complexity of economic activities.⁸⁴ Increasing complexity is associated with higher

levels of GDP and growth, and reduction of inequality.⁸⁵ That process is ultimately the result of innovation. Promising actions in all these strategies is the use of empirical data on production, exports and innovation to identify specific technology trajectories to guide the transition towards sustainable development. Promising technological trajectories and new industries can be identified, using patent databases, benchmarking early movers based on their comparative advantage, and/or by using the "product space" and measures of product complexity.⁸⁶

Industrial policies. Contributing scientists saw as key to promote industries that are developing relevant technologies, especially those willing to manufacture in developing countries, while cutting subsidies and tax breaks for those that are not sustainable. In developing countries, some governments may be willing to legislate this, if the right incentives are provided by international development banks.⁸⁷ In high-income and innovative regions, high environmental standards for industry need to be enforced, in order to provide benchmarks for others and possibly enforce them via intergovernmental agreements with the help of NGOs. Others suggested to reconsider the desirability of ever increasing worldwide trade and exploring optimal forms of protectionism. In this view, regional or global policies with respect to sustainability standards could be explored, and development aid and trade could be directed more towards small-scale and local support with technologies that benefit the poor in terms of food accessibility, basic amenities such as electric light, water, health and education.⁸⁸

3.2.3 Putting technology at the service of inclusion

Access to affordable, modern technology for everyone, especially in developing countries. Scientists underlined that developing countries, including SIDS and LLDCS need better technology access which is currently constrained by inadequate R&D funds and human skill formation. According to J.A. Schumpeter, it is the introduction of a new product and the continual improvements in the existing ones that lead to growth and development. Hence, innovation is the ultimate driver of long-run economic growth, and barriers to technology access limit development perspectives of countries. Against this background, policy-actions are needed that lead to comprehensive, non-discriminatory and transparent cooperation among developing, developed countries and SIDS.⁸⁹ Contributing scientists proposed that developed countries share technology and experiences with those developing countries that are lacking state-of-the-art green technology.⁹⁰ Some also stated that the latest technologies should be freely available in poorer countries, and that patents should not constitute barriers for technology diffusion to these countries. In this context, new business models and patent pools for sustainable technologies have proven useful. For example, within three

years of NIKE's launch of a patent pool in 2010, more than 400 technologies have been made available and accessible through the platform.⁹¹

Inclusive innovation policies can help achieve more equitable, sustainable and inclusive development. Inclusive innovation refers to the inclusion in some aspect of innovation of groups that are currently marginalised.^{92, 93}

The group most often identified is that with the lowest income, but may also include women, youth, persons with disabilities and ethnic minorities. Various UN entities have studied and tested the issue technology and inclusive innovation and their implications for development.⁹⁴ For example, UNCTAD's work emphasizes the need to understand - in the context of innovation policies - the particular failures of innovation systems that hinder the attainment of inclusive goals. In particular, to integrate social objectives in STI policies, it is important to consider the specific situations and needs of poor people, women and other groups, as illustrated in UNCTAD research on STI policies⁹⁵ and technologies for women.⁹⁶ Technologies that create barrier-free environments can improve societal inclusion of deaf and blind people and even support disaster management and prevention.⁹⁷ On a related note, it should be noted that many technologies are associated with "jobless growth" as identified by the ILO. These technologies may lead to higher productivity but reduce employment and thus jeopardize "inclusive development".

Technology gaps between countries and groups of people have been a dynamic issue of concern in the sustainable development discourse. Technology gaps exist in all sectors and their nature and severity in terms of being a development constraint differ greatly. This is evident in the World Investment Reports which have analysed these gaps in infrastructure, low-carbon economy, agriculture, global value chains, and the SDG sectors.⁹⁸ *New technology gaps often emerge with the application of new technologies*, such as big data, the Internet of Things, 3D printing, and digital automation (see Section 3.3), which could have wide-ranging implications that widen - not minimize - existing inequalities.⁹⁹ While such technologies are at an early stage, it is important for countries to begin to understand them, identify potential implications, and use foresight activities to guide policy planning exercises.

*An ecosystem approach to policy can help bridging existing technology gaps.*¹⁰⁰ Prominent examples include digital technology gaps which comprise connectivity, capability and content elements. There remain considerable connectivity divides in LDCs, SIDS and developing countries as a whole.¹⁰¹ The connectivity divide is greatest in countries with high rural population shares. To bridge the divides in terms of capabilities at the individual, government and enterprise levels, ICT usage and other complementary skills are needed. Policy actions include creating alternate

spaces for learning, involving community centres, creating better metrics of ICT usage, making efficient use of digital platforms, engaging in continuous experimentation, exploring strategic collaborations, popularizing open government data models, developing comprehensive citizen engagement strategy, and adopting participatory e-governance models for the 'shared economy'. The divides in terms of content continue to be large, with the virtual content being highly skewed along language, geography and themes. Locally relevant content can be promoted by establishing local innovation centres and technology hubs, promoting local internet exchange points, increasing support for open data initiatives and organize contests and challenges.

Interests of underserved populations should be systematically taken into account throughout the innovation process. Otherwise, impoverished and future populations may have to deal with technologies poorly suited for them which were chosen by others. There is also untapped potential for end-users to adapt technologies for use in new settings.¹⁰² In fact, a survey of research project "The Diffusion of Innovation in Low-Income Countries" in Ghana identified that responding to customers' needs and requirement as the most important source of innovation in Africa.¹⁰³ Channels of communication between underserved populations and powerful actors could improve innovation systems. Therefore, it is proposed that actors with convening power and normative authority should identify ways to more meaningfully engage marginalized populations in innovation systems.¹⁰⁴ For example, international NGOs and UN entities can help governments to directly engage marginalized populations when negotiating norms and establishing priorities. This requires capacity-building among less-powerful populations to represent their interests in global forums. Previously, international organizations primarily focused on technology transfer, often through financing arrangements to export technology from more advanced countries to developing countries. However, newer forms of cooperation seek to more deeply engage developing country actors in the process of technology invention and selection¹⁰⁵ and fostering new collaborative R&D arrangements.¹⁰⁶

Access to and use of "Assistive Technology" for people with disabilities should be promoted. Assistive Technology enables people with disabilities to participate in social life and to live independently. Assistive Technology, inter alia, helps in the following personal areas: medical treatment, training, personal care and protection, mobility, housekeeping, communication, handling objects, and accessing employment. These technologies are a key element captured in the *UN Convention on the Rights of People with Disabilities (CRPD) of 2006*. The CRPD includes accessibility as a general principle and obliges state parties to "promote the availability, knowledge and use of assistive devices and technologies relating to habilitation

and rehabilitation.”¹⁰⁷ The use of Assistive Technology is increasing¹⁰⁸ and the trend is likely to continue, as there is not enough human labour available to provide one-on-one dedicated, individualised care. Exploring the socio-cultural context is important, as cultural norms can act as barriers to access and usage of Assistive Technology by people with disabilities.¹⁰⁹ In multi-ethnic, multi-cultural societies, there are typically significant differences in the uptake of assistive technology by people with disabilities from various ethnic backgrounds.¹¹⁰ Most access and usage challenges in relation to assistive technologies are not related to technological advancements or developments, but are connected to the barriers associated with its uptake.^{111, 112}

On-the-ground solutions and technological innovations should be considered as a core component of livelihood strategies and an enabling factor of current urbanization processes, in addition to pre-existing models of resource provision through large-scale technological networks.^{113, 114} Flexible technological configurations and residents’ collaborative practices are essential for meeting the daily water needs of people who do not have access to piped water.¹¹⁵ Such configurations work outside large-scale networked piped water systems and make use of locally ready-to-use solutions to access and store water such as plastic storage containers, mobile vehicles, etc. This is also the case of energy provision and housing and transport.¹¹⁶ Local governance processes play a crucial role in the introduction and use of new technologies. These need careful consideration to avoid generating new problems while dealing with existing ones.^{117, 118}

Intervention research drawing on cognitive science, psychology, behavioural economics, and anthropology. An important policy element to leverage technology is to ensure programs understand and address the psychological and social dimensions that limit individuals from optimally engaging with technology.¹¹⁹ For example, certain technological solutions in the health sector are only as effective as an individual’s capacity to understand, use and innovate around them. Examples of how cognitive-behavioural approaches can be effective include text reminders to patients to increase drug adherence¹²⁰ and inspirational videos showing how similar groups improved their socio-economic status.¹²¹ New development approaches are required that not only take into account how people think, feel and do within their local context, but must move beyond to create interventions that directly foster individual’s power, voice and agency. Recent research on targeted empowerment interventions for women that strengthen individual agency demonstrated a nearly tripling of sales for clean energy micro-entrepreneurs in Kenya¹²² and significant enhancements in relationships and well-being.¹²³ Intervention research drawing on cognitive science, psychology, behavioural economics, and anthropology is critical to advance human capacity to

leverage technology for the SDGs.¹²⁴

Informal cultural norms and the nexus to formal rules need to be explicitly considered when assessing technology needs and gaps. Technology needs and gaps are context specific, and that the lineaments of the context need to go far beyond the ones currently being considered, namely, city size, development stage, and countries in special situations. Communities and societies are held together by shared and symbiotically interacting formal ‘rules’ and informal cultural ‘norms’. A mutually supportive evolution of rules and norms is a prerequisite for sustainable and inclusive development. The introduction of new technologies meant to promote sustainable and inclusive development has the potential to cause - and often does, as human experience has shown - incongruity between the pace of evolution of rules and norms. This could dampen community’s enthusiasm for the uptake of new technologies and, more seriously, engender outright hostility towards them, thereby frustrating the objective of sustainable development.^{125, 126, 127, 128, 129}

3.2.4 Building institutions that support sustainable technology progress

Institutions are critical for leveraging technologies. These rules and regulations in society can open opportunity spaces for innovating and making best use of technological innovations.^{130, 131} *Institutions need to be reformed to re-orient innovation systems towards sustainable development.* All stages of innovation and all relevant decision-making levels need to be considered at the outset. For example, reform efforts in the biomedical innovation system previously focused on just one stage, such as driving invention for neglected diseases, adapting vaccines to be heat-stable, or decreasing the price of HIV/AIDS medicines. More recently, institutional reforms involve using publicly-financed “push” and “pull” incentives, whereby affordability measures are being built into the R&D processes from the very beginning. Governments of both industrialized and developing countries are being asked to contribute to a global biomedical R&D fund for this purpose.¹³² Other examples are the creation of carbon prices through various carbon markets which typically require better incentives for private energy R&D and concerted public R&D investment.¹³³

There is a need for research and development and incentives for the deployment of cheaper, highly efficient technologies with systemic benefits. These technologies have the potential to transform existing technology systems leading to multiple benefits across the SDGs. Examples include off-grid electricity systems with storage, electric mobility, and novel antimicrobial medicines.

Significant R&D is needed for urban and rural decentralized electric power systems (perhaps even direct current^{134, 135}) and for interactions with new options such as heat

pumps for space heating, heat and power storage and electric mobility. These systems must become central to the UN or most governments' sustainability agendas.¹³⁶ In addition, adequate community and business models need to be found to operate such systems in terms of reliability, affordability, sustainability and safety (incl. privacy).^{137, 138} In this context, the existing research gaps need to be bridged between those in the social sciences, in policy and those in the electrical engineering^{139, 140} Off grid electricity systems have multiple SDG benefits. For example, they can be used for storage and transportation of perishable food, as well as for drying grain¹⁴¹ and thus can help reducing food spoilage.¹⁴²

Cheaper, highly efficient technologies must become available in key SDG areas. R&D in innovative technologies, general purpose technologies, and basic science are prerequisites, as are energy efficiency laws. A successful example is Japan's top-runner programme¹⁴³ which could be a model to be explored by other countries. Global explicit carbon prices could help reducing greenhouse gas emissions, but - to be effective - they would require all countries to introduce similar levels of carbon prices which appears unrealistic a present and might also raise concerns with regard to ensuing impacts on the achievement of other SDGs.^{144, 145} Cheaper, highly efficient bio-energy technologies, solar energy equipment, improved cookstoves, low emissions power plants and less dirty coal technology might also be key.¹⁴⁶

More R&D investments are needed in the field of antimicrobial research and diagnostic technology. Innovation in technologies is crucial on all levels of healthcare and beyond from point of care diagnostics with an aim to rationalise use of antibiotics to novel antibiotics themselves and their pharmacological alternatives. SDGs should be used as an instrumental inter-sectoral platform through which an underlying antimicrobial resistance as a threat to the world's sustainable development can be addressed collaboratively.¹⁴⁷

The needed technologies and priorities in cities vs. rural areas often differ greatly in both developed and developing countries. More than half of all people already live in cities, and by mid-century it will be two-thirds. Technology progress has enabled mega-cities to emerge, but continued progress is required even to sustain basic service delivery and reasonably healthy lives in these growing cities. "Smart cities" are emerging with hundreds of smart city projects underway in developed and developing countries. Smart cities and infrastructure can be used to pave the way for inclusive urbanization, or they can exclude poorer sections of the society. To make city development inclusive, some smart infrastructure applications are designed exclusively for marginalized people, including those in informal settlements, people of old age and people with disabilities.¹⁴⁸

It is important to *harness the local innovation system to sufficiently localize the smart infrastructure concepts.* Policy instruments for this purpose include establishing urban innovation units and living labs, promoting open data and open science models, exploiting regional innovation networks and global collaborations, and bringing together science parks, business incubators and innovation hubs.¹⁴⁹

The level of concentration of public resources must be kept within environmental carrying capacity. Mega-cities require specific attention. The urban scale of cities is constrained by spatial, land, water, and energy resources, but these constraints can be relaxed via technological breakthroughs, hence allowing the city to grow further. As, technological breakthroughs are not unlimited, non-technological solutions need to be explored.¹⁵⁰ In the case of megacities, institutional approaches can provide environmental solutions through *re-defining megacities' functions through legislation and balanced distribution of public resources, in particular, quality educational and medical care facilities.*¹⁵¹

Institutions could promote development of low cost local technology solutions based on community knowledge, in particular for disaster risk reduction, urban health and well-being. The crowd sourcing technique for neighbourhood mapping can prove to be very effective for collecting risk information for disaster risk reduction. Technologies using innovative geospatial techniques, such as disaster/urban zonation, urban heat island mapping and exposure/vulnerability analysis in a multi-hazard framework are promising for mitigating risks and pursuing sustainability.¹⁵² Development of green resilient infrastructure-enabled urban spaces could provide multiple benefits and support the SDGs.^{153, 154} It involves less resource-intensive green engineering, allowing traditional knowledge to build and manage and inclusive participation during the process of re-generation. It enriches ecological and socio-cultural resources and provides resiliency towards extreme events, as urban climate modification¹⁵⁵ and water management¹⁵⁶ increases coping capacity of urban areas.^{157, 158, 159, 160, 161}

Coordinated global monitoring and modelling of many different types of data sets requires *new tools and scientific innovations for data collection and analysis.* Devising metrics, establishing monitoring mechanisms, evaluating progress, enhancing infrastructure, standardizing and verifying data should be top priorities for the scientific community and policymakers alike.¹⁶² In this context, the International Council for Science, the International Social Science Council, the Inter-Academy Partnership, and the World Academy of Sciences have developed a new global accord that identifies the opportunities and challenges of the data revolution as today's predominant issue for global science policy, and proposes principles and practices for open access to research data.^{163, 164} Guiding frameworks might be useful for assessments of large, international

projects. They could be supported by firmer and more consistently enforced policies of international development banks and other donors.¹⁶⁵

Big data which has emerged as a new ecosystem of new data, new tools and new actors¹⁶⁶ can help both monitor and promote the SDGs.¹⁶⁷ It is particularly promising for inferring or proxying SDGs at fine levels of temporal and geographical granularities. Examples include poverty mapping, disasters monitoring, urban dynamics,¹⁶⁸ resilience to climate change-induced shocks.^{169,170} Big Data can and will also be increasingly used directly by people and groups outside of the realm and reach of traditional policy and measurements systems.¹⁷¹ Individuals and communities can be allowed and incentivized to engage in policy debates through and about 'their' data seeking greater control over the use of their data and holding those in power to higher standards. Big and Open data need to meet in a "new deal on Data" in which the most vulnerable would have a stronger say in how and for whom policies are designed. Technologies for GIS analysis of geospatial data could also support interventions in many areas, for example, to identify suitable areas for mobile water treatment.¹⁷² At the same time, it is important to strengthen official statistics for monitoring SDG indicators, in view of Member States emphasis on nationally owned data, and in order to make actual measurements rather than rely merely on proxy data.¹⁷³

3.3 Scientists' perspectives on crucial emerging technologies for the SDGs until 2030

A number of science-related processes routinely identify emerging technologies and elements of technology solutions for achieving the SDGs. Those include academies of sciences, individual academics, NGOs, the private sector and the UN system.¹⁷⁴ Mapping these lists to the SDGs could be a productive way to engage the science and engineering community more broadly in contributing to the goals, as illustrated by WFEO's mapping of the US National Academy of Engineering's Grand Challenges.¹⁷⁵

For the present chapter, scientists were asked: "*Which technologies and what level of their performance and deployment will be most crucial until 2030?*". Sixty-one scientists provided inputs in response to the question and another 97 scientists had discussed various technologies in their GSDR science-policy briefs.¹⁷⁶ Many of them also pointed out specific opportunities and threats related to the identified technologies. Table 3-3 provides an overview of perspectives. Identified technologies fall into the bio-tech, digital-tech, nano-tech, neuro-tech and green-tech clusters.

New technologies are developing at exponential pace, faster than ever before. The Fourth Industrial Revolution

is fundamentally different from the three previous revolutions.¹⁷⁷ It fuses fields of physics, biology, computer science and many more, impacting all disciplines, industries and the world's economy. By 2030, many new technologies will emerge, while current nascent or immature technologies will reach the commercialization stage and may help addressing some of the SDGs. Conversely, the SDG agenda may play an important role in this transformation, as it will direct and could guide future developments, at the same time serving as a tool and change framework.¹⁷⁸

Two most crucial technology clusters for the SDGs may be energy technologies lowering the cost of clean, non-carbon based energy technologies and carbon sequestration, and *information, communication, and computer technologies* providing new information and analytics that can help us to make smarter decisions and provide more effective services and new innovation in every SDG area. New rapid advances in *biotechnology, nanotechnology and neurotechnology* are other areas with great potential for affecting many sectors. The biggest challenges will likely be in sectors, such as manufacturing, construction, and transportation, where new innovations are needed that can expand rather than reduce employment opportunities and ensure that more people move out of poverty into the middle class in all countries.¹⁷⁹ Reflecting this, science-policy briefs submitted for the GSDR highlight the importance of synthetic biology,¹⁸⁰ biotechnology,¹⁸¹ nanotechnology,¹⁸² and renewable energy technologies,¹⁸³ in order to provide clean water and energy for all. Some contributing scientists are convinced that "*there is no limit to the number of innovations that could help nations accelerating implementation of SDGs*".¹⁸⁴

While these technologies have great potential and are a testament to human ingenuity, it will also be important to *minimize risks* and draw attention to potential problems or dangers arising from new technologies and chemicals such as synthetic biology, nanotechnology applications, or genetically modified organisms. There are no risk-free technologies. Even the most sustainable technologies have had unintended and known adverse impacts. Another concern is that emerging information and bio-technologies could have adverse impacts on community and society cohesion and value systems. Some scientists even suggest that "*Sustainable technologies do not exist!*".¹⁸⁵

Some warn against looking at technology as a panacea, and point out the limits of technology to address ultimate limits of the ecosystem, and its subordination to politics.¹⁸⁶ According to them, high performance technologies alone will be insufficient for SDG achievement. *Alternative social technologies* and perspectives may also be needed that go well beyond current approaches.^{187, 188, 189} Some contributing scientists see this as the most crucial issue from now to 2030.¹⁹⁰

Table 3-3: Crucial emerging technologies for the SDGs until 2030, as identified through outreach of the GSDR team to scientific communities around the world

Technology cluster	Crucial emerging technology for the SDGs until 2030	Opportunities in all SDG areas, including:	Potential threats, including:
Bio-tech	Biotechnology, genomics, and proteomics; gene-editing technologies and custom-designed DNA sequence; genetically modified organisms (GMO); stem cells and human engineering; bio-catalysis; synthetic biology; sustainable agriculture tech;	Food crops, human health, pharmaceuticals, materials, environment, fuels.	Military use; irreversible changes to health and environment.
Digital-tech	Big Data technologies; Internet of Things; 5G mobile phones; 3-D printing and manufacturing; Cloud computing platforms; open data technology; free and open-source; Massive open online courses; micro-simulation; E-distribution; systems combining radio, mobile phone, satellite, GIS, and remote sensing data; data sharing technologies, including citizen science-enabling technologies; social media technologies; mobile Apps to promote public engagement and behavioural change; pre-paid system of electricity use and automatic meter reading; digital monitoring technologies; digital security technology.	Development, employment, manufacturing, agriculture, health, cities, finance, absolute “decoupling”, governance, participation, education, citizen science, environmental monitoring, resource efficiency, global data sharing, social networking and collaboration,	Unequal benefits, job losses, skills gaps, social impacts, poor people priced out; global value chain disruption; concerns about privacy, freedom and development; data fraud, theft, cyber-attacks.
Nano-tech	Nano-imprint lithography; nano technology applications for decentralized water and wastewater treatment, desalination, and solar energy (nanomaterial solar cells); promising organic and inorganic nanomaterials, e.g., graphene, carbon nanotubes, carbon nano-dots and conducting polymers graphene, perovskites, Iron, cobalt, and nickel nanoparticles, and many others;	Energy, water, chemical, elec-tronics, medical and pharmaceutical industries; high efficiencies; resources saving; CO ₂ mitigation.	Human health (toxicity), environmental impact (nanowaste)
Neuro-tech	Digital automation, including autonomous vehicles (driverless cars and drones), IBM Watson, e-discovery platforms for legal practice, personalization algorithms, artificial intelligence, speech recognition, robotics; smart technologies; cognitive computing; computational models of the human brain; meso-science powered virtual reality.	Health, safety, security (e.g., electricity theft), higher efficiency, resource saving, new types of jobs, manufacturing, education.	Unequal benefits, de-skilling, job losses and polarization, widening technology gaps, military use, conflicts.
Green-tech	<p>Circular economy: technologies for remanufacturing, technologies for product life-cycle extension such as re-use and refurbishment, and technologies for recycling; multifunctional infrastructures; technologies for integration of centralized systems and decentralized systems for services provision; CO₂ mitigation technologies; low energy and emission technology.</p> <p>Energy: modern cookstoves with emissions comparable to those of LPG stove; Deployment of off-grid electricity systems (and perhaps direct current); mini-grids based on intermittent renewables with storage; advances in battery technology; heat pumps for space heating, heat and power storage and electric mobility (in interaction with off-grid electricity; smart grids; natural gas technologies; new ways of electrification; desalination (reverse osmosis); small and medium sized nuclear reactors; biofuel supply chains; solar photovoltaic, wind and micro-hydro technologies; salinity gradient power technology; water saving cooling technology; LED lamps; advanced metering.</p> <p>Transport: integrated public transport infrastructure, electric vehicles (e-car and e-bike), hydrogen-fueled vehicles and supply infrastructures.</p> <p>Water: mobile water treatment technology, waste water technology, advanced metering infrastructure.</p> <p>Buildings: sustainable building technology, passive housing.</p> <p>Agriculture: Sustainable agriculture technology; Innovations of bio-based products and processing, low input processing and storage technologies; horticulture techniques; irrigation technologies; bio-organometallics which increase the efficiency of biomimetic analogs of nitrogenase.</p> <p>Other: Marine Vibroseis, artificial photosynthesis</p>	Environment, climate, biodiversity, sustainable production and consumption, renewable energy, materials and resources; clean air and water; energy, water and food security; development, employment; health; equality.	New inequalities, job losses; concerns about privacy, freedom and development.
Other	Assistive technologies for people with disabilities; alternative social technologies; fabrication laboratories; radical medical innovation; geo-engineering technologies (e.g. for iron fertilization of oceans); new mining/extraction technologies (e.g., shale gas, in oceans, polar, glacier zones); deep sea mining technologies;	Inclusion, development, health, environment, climate change mitigation, resource availability.	Pollution, inequalities, conflict.

Sources: Results of an online survey among scientists and experts conducted in April 2016 and GSDR science-policy briefs.

The groups of technologies listed in Table 3-3 are discussed in more detail in Annex 2, entitled “Scientists’ perspectives on crucial emerging technologies for the SDGs until 2030”.

Some scenario analysts provided initial quantifications for technology deployment until 2030. For example, according to one energy economist, in the case of green-tech in industrialized countries, market penetration of smart grids might reach 20 per cent of the electricity market, all new buildings would be energy efficient while all buildings existing today would be refurbished to become energy efficient, electric vehicles would reach market shares of 50 per cent of new registrations due to vastly improved battery performance and low costs, nuclear power would provide some 60 per cent of baseload generation,¹⁹¹ hydrogen-fueled vehicles and supply infrastructures would be commercialized and natural gas would become the largest fossil fuel.¹⁹² In developing countries, electrification not only of households but of small urban and rural businesses and agricultural small holders could be fully achieved, desalination (reverse osmosis) deployed, small and medium sized nuclear reactors could provide some 10 per cent of baseload generation, agriculture would be mechanised; mini-grids development would be based on intermittent renewables with storage, grid expansion would be twice today’s rate, and IT for education deployed even in remote areas.

Long-term technology roadmaps can support business development and policy planning. Systematic road-mapping and scenario work for all SDG areas would be highly beneficial and help engaging a broader cross-section of scientists, engineers and other stakeholders. A number of technology foresight experts have developed indicative timelines for deployment of the technology clusters from 2016 to 2030 which could serve as a good basis for a comprehensive analysis that encompasses the full SDG range.

The CSTD Secretariat at UNCTAD has recently pioneering technology foresight for areas under debate in the UN. For example, one priority theme for the 19th session of CSTD was “Foresight for Digital Development.” Several CSTD documents,^{193, 194, 195} focused on how countries can use foresight to assess the likely impact of emerging digital developments. They offered potential global scenarios for the trajectory of each technological trend. These could potentially serve as a starting point for countries to initiate their own foresight exercises based on their specific contexts.

3.4 Conclusions

The 158 scientists who contributed their perspectives to this chapter represent 43 disciplines and all world regions. The collection of their views provides initial guidance that could prove useful in the preparation of an in-depth technology chapter for the Global Sustainable Development report in 2019. Much in-depth work remains to be done – collaboratively by external scientists, engineers, UN staff experts, in consultation with the Scientific and Technological Community Major Group co-organized by ICSU, ISSC and WFEO.

Selected actions or policy elements suggested by scientists included: national and international action plans and technology roadmaps; build effective national science-policy interfaces (scientists to analytically support public decision-making); facilitation learning across communities and including underserved communities; cluster analysis, foresight and scenarios; science roadmaps to include affordability and inclusion measures to be built into R&D processes from the outset; invest in both new and old technologies, in infrastructures and granular technologies, in increased performance of advanced technologies and technology adaptations for underserved communities; identify promising technological trajectories and new industries for each country; and engage communities and the poorest and most vulnerable in identifying needs.

Scientists identified many crucial emerging technologies for the SDGs and suggested for further policy elaboration. They fall into the bio-technology, digital-technology, nano-technology, neuro-technology and green-technology clusters. However, very little information exists on the expected or desired level of performance and deployment of these technologies until 2030. To estimate these levels in various contexts, collaboration on SDG scenarios and roadmaps will be important. Systematic road-mapping and scenario work for all SDG areas would be highly beneficial and help engaging all stakeholders.

The technology we have today is robust enough to keep scientists, engineers and all relevant stakeholders engaged and networked. New technologies in the future will be even more powerful tools for building an effective, global science-policy cooperation leveraging technology for a better future for all as envisioned in the SDGs.

Online Annex: List of technology-related science-policy briefs for the GSDR see <http://sustainabledevelopment.un.org/globalsdreport/2016>

Endnotes

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INCLUSIVE INSTITUTIONS FOR SUSTAINABLE DEVELOPMENT

The new Agenda recognizes the need to build peaceful, just and inclusive societies that provide equal access to justice and that are based on respect for human rights (including the right to development), on effective rule of law and good governance at all levels and on transparent, effective and accountable institutions.

A/RES/70/1. Transforming our world: the 2030 Agenda for Sustainable Development. Resolution adopted by the General Assembly on 25 September 2015.

4.1 Introduction

The 2030 Agenda calls for transparent, effective, inclusive and accountable institutions to advance poverty eradication and sustainable development. It aims to ensure responsive, inclusive, participatory and representative decision-making at all levels, emphasizing the importance of public access to information, protection of fundamental freedoms and the promotion of non-discriminatory laws and policies for sustainable development.¹

“Institution” is a broad and multi-faceted term, which encompasses a range of structures, entities, frameworks and norms that organize human life and society. While institutions are certainly not the only means to reduce inequalities, inclusive institutions are critical enablers of equity and are central to achieving the objective of leaving no one behind. The 2030 Agenda does not prescribe institutional models for the national level, but outlines principles that institutions should strive to achieve, such as “effectiveness, inclusiveness, and accountability” (SDG 16), “responsive, inclusive, participatory and representative decision-making at all levels” (target 16.7) and “policy coherence” (target 17.14).

Different scientific disciplines view institutions through various perspectives. From outcomes of cognitive processes in the form of mental representations that are context-dependent (time and space) and domain-specific,² to sets of rules and norms.³ Institutions are supported by beliefs that facilitate their dissemination and their rules are inserted in hierarchical, power relationships between individuals.⁴ Formal institutions include written constitutions, laws, policies, rights and regulations enforced by official authorities.

Achieving any particular target under the SDGs will require a combination of factors, including: legal, regulatory components; multiple institutions intervening at various levels; and potentially broader societal changes, e.g. in social norms, which themselves can be spurred by changes in institutions. For example, the advancement of gender equality requires a range of actions at all these levels, and the intervention of a range of institutions with different mandates and purposes. In other words, no target related to inclusiveness can generally be achieved through a single institution. Conversely, individual institutions, especially those with broad mandates, can contribute to inclusiveness in many different areas as well as society-wide. For such institutions, it is important to assess both how inclusive they are, and how they foster inclusiveness through their actions.

Among the many types of institutions that should be examined due to their importance in fostering inclusiveness, this chapter examines how two specific types of institutions, national councils for sustainable development (NCSDs) and national parliaments, have helped promote inclusiveness in relation to the achievement of sustainable development. While the choice of these two types of institutions, among many others, is illustrative, both NCSDs and parliaments are important institutions for sustainable development. Efforts to promote sustainable development at the national level have attempted to address challenges related to integrated decision-making by encouraging the establishment of multi-stakeholder and cross-sectoral national mechanisms.⁵ These mechanisms are broadly referred to as National Councils for Sustainable Development (NCSDs). In turn, parliaments have played an important role and will be crucial for the 2030 Agenda implementation. The 2030 Agenda acknowledges “the essential role of national parliaments through their enactment of legislation and adoption of budgets and their role in ensuring accountability for the effective implementation of our commitments”, but also in inclusiveness in drawing “on contributions from indigenous peoples, civil society, the private sector and other stakeholders”.⁶ Through law-making and budgets, parliaments can ensure inclusiveness and hold governments accountable for their policies on ensuring to leave no one behind.

The chapter draws on existing studies and reviews across countries and regions, synthesizing lessons that could guide countries' efforts to adapt their institutional frameworks as they embark on the journey to implement the new Agenda.

4.2 Inclusive Institutions for Sustainable Development

Useful lessons for strengthening institutions to advance sustainable development can be learned from the efforts made to implement the outcomes of the first Conference of Environment and Development in Rio de Janeiro, Brazil, in 1992, the World Summit on Sustainable Development in Johannesburg, South Africa, in 2002 and the Conference on Sustainable Development (Rio+20) in Rio de Janeiro, Brazil in 2012.

For example, by definition, sustainable development requires an integrated approach to decision-making, incorporating social, environmental and economic dimensions. Since 1992, the integrated nature of sustainable development has posed challenges to institutions that were often not designed to work across boundaries. Scholars have tried to address these challenges with various concepts, such as horizontal integration,^{7,8} boundary-spanning,⁹ strategic public management,¹⁰ and meta-governance.¹¹

Examples of informal institutions are (the usually unwritten) social norms, customs or traditions that shape thought, attitudes and behaviour.^{12,13} Formal and informal institutions structure the distribution of opportunities, assets and resources in society. For example, political settlements establish the formal rules for managing political and economic relations (such as electoral processes, constitutions, and market regulations), as well as the informal division of power and resources.¹⁴

There are different types of institutions, depending on the domains they organise: those governing the reproduction of society – notably individuals' life-cycle, memberships and statuses¹⁵ and those regulating interactions, exchanges (e.g., codes of conduct), in various domains (e.g., political, economic, social). Economic relations, political governance and social norms within families and communities are key institutional domains influencing development outcomes. Together, these institutions determine the degree to which social relations are inclusive.

Each country has a different “starting point” and preference for governance styles, due to constitutional settings, traditions, culture, political practice, geography and resulting environmental, social and economic circumstances.¹⁶ However, the demands of participation in various international regimes makes policy coordination across government a key factor in determining effective

and inclusive governance at the national level.¹⁷

With such sweeping scope and reach, institutions are fundamental to determining whether a person or community is excluded or included from development and progress. Institutions can trigger behaviors and trends that can have positive or negative impacts for developmental outcomes, and in particular for inclusiveness. On the other hand, power holders can shape institutions for the benefit of some rather than all groups of society. Institutions that are not inclusive potentially infringe upon rights and entitlements, can undermine equal opportunities, voice and access to resources and services and perpetuate economic disadvantage. They can also have a negative impact on non-economic dimensions of poverty, including lack of access to services, lack of voice in decision-making, and vulnerability to violence and corruption. Moreover, institutions that are not inclusive in one sphere can multiply disadvantage in others.¹⁸

Inclusive institutions give equal rights and entitlements, and enable equal opportunities, voice and access to all resources and services. They are typically based on principles of universality (e.g. universal access to justice or services; universal age-related state pension), non-discrimination (e.g. meritocratic recruitment in the civil service; inheritance laws that protect widows' land rights), or targeted action, which is needed where some people and groups are particularly disadvantaged, and therefore require differential treatment to achieve the equivalent outcomes (e.g. quotas to increase the proportion of women political representatives; budget rules that prioritise investment in disadvantaged areas).

Economic institutions shape the rights,¹⁹ regulatory framework,²⁰ and degree of rent-seeking and corruption, in land, housing, labour and credit markets.²¹ Examples of formal economic institutions include property rights and labour laws. Many cross-country statistical studies find that more inclusive economic institutions improve economic outcomes.²² The quality of institutions – such as security of property rights and strength of the rule of law – is a strong determinant of income levels.²³ Some cross-country studies suggest the reverse order of causality;²⁴ specifically, that income levels, educational attainment and economic growth all lead to stronger institutions, not the other way around.²⁵

Regarding political institutions, their quality, gender balance and their level of genuine inclusiveness seem to be important determining factors for sustainable development. Some cross-country econometric studies find that better – more inclusive – governance reduces poverty and improves human development outcomes relating to, for example, infant mortality,²⁶ literacy,²⁷ and health.²⁸ While evidence has shown that holding elections alone has no significant

impact on development, deeper measures of political inclusion – including political competition, issues-based political parties, and competitive recruitment to these parties – have significant effects.²⁹

There is less research on the impact of inclusive social norms. One study suggests social trust has a strong positive effect on economic growth.³⁰ Norms of non-discrimination against women, ethnic, religious and caste minorities may be particularly important in this regard.³¹ Discriminatory social norms can trap people in exploitative relationships and push them into chronic poverty. For example, the Chronic Poverty Research Centre, based on longitudinal panel data from multiple countries, identifies five chronic poverty traps: insecurity-reduced capacity of poor households to cope with conflict, shocks and natural hazards; limited citizenship - lack of a meaningful political voice and effective and legitimate political representation and power; spatial disadvantage - remoteness, political disadvantage and weak integration; social discrimination and social relationships – of power, patronage, empowerment, competition, collaboration, support; and poor work opportunities - work opportunities can be limited, inaccessible, or exploitative for poor people, in particular women and girls.³² Given the linkages between poverty, social discrimination, development and human rights, national human rights institutions can play a role in advising State institutions and monitoring progress in the implementation of the Agenda at the local, national, regional and international levels. They can help ensure accountability to the people by disclosing inequality and discrimination, including through innovative and inclusive approaches to data-collection and partnerships with rights-holders, vulnerable and marginalised groups.

Strengthening inclusive institutions involves transforming power relations and incentives,³³ incorporating marginalized people and groups,³⁴ addressing social, political and economic drivers of exclusive institutions,³⁵ decreasing tension between new and existing institutions,³⁶ targeting and unifying intervention and integrationist policies,³⁷ addressing gender inequality, understanding social norms and behavioural changes; and promoting coherence between support to institutions operating in different spheres (economic, political and social).³⁸

Institutions are constituted and perpetuated by people, and changing them is always a complex process. Reforming institutions is not just about passing new regulations or establishing new bodies. The design and implementation of institutions needs to take into account the capacities of people and organisations. Consequently, overly ambitious and technocratic institutional reforms have often resulted in little improvement being made in function, in spite of changes in appearances and structures.³⁹

Institutions mirror the culture and history of the national contexts from which they emerge and in which they are meant to work. This cultural dimension of institutions means that “best practices” are elusive and at best relative. The cultural dimension of institution-building and their underlying values have to be taken into account (e.g. by striving for at least a minimum of cultural compatibility during transformations to new and more inclusive institutions), as they can be very resistant to change and not accounting for them can lead to failure in changing institutions.⁴⁰

It is, therefore, important to support drivers of institutional change. Examples used over the world have included facilitation and strengthening of stakeholder feedback mechanisms, review mechanisms, and support to design and implementation of client voice mechanisms (e.g. citizen report cards), as well as promotion of public information disclosure at national and local levels. Large numbers of better educated, and politically and economically aspirational young men and women, effective organisations to represent them, and the middle classes that support more inclusive institutions are all vital. Growing migration and urbanisation offer possibilities for social mobility and stronger voices for inclusive institutional change, but can also increase marginalisation within cities.⁴¹

It is in this context that the chapter looks at two particular types of institutions, NCSDs and parliaments. Even though they are of different nature and serve different functions, they both strive for representation and inclusion and can be important mechanisms to ensure that no one is left behind in the implementation of the 2030 Agenda.

4.3 National Councils for Sustainable Development

National Councils for Sustainable Development (NCSDs) were once considered critical to achieving integration in decision-making and participation, two dimensions that were at the heart of the concept of sustainable development. NSDCs witnessed rapid development in the first five years after the Earth Summit.⁴² Today, the number of NCSDs and similar bodies has reached over 100 globally, with a wide variety of forms and functions.⁴³ However, they have had mixed levels of success over the past two decades years, with some fading from the policy landscape.⁴⁴ Yet, the challenges that were the rationale for their creation have not disappeared. In particular, NSDCs typically answer the request for “responsive, inclusive, participatory and representative decision-making at all levels” (target 16.7) and “policy coherence” (target 17.14) articulated in the 2030 Agenda. Hence, NCSDs, whether newly created or revived, may have the potential to play an effective role in implementing the 2030 Agenda, helping

countries to “develop ambitious national responses”, building on “existing planning instruments, such as national development and sustainable development strategies, as appropriate”.⁴⁵

This chapter, in line with the theme of this Report, mainly approaches NCSDs from the angle of inclusiveness rather than covering the whole spectrum of NCSDs’ functions.⁴⁶ The review is limited by the limited attention given to NCSDs by academia. But despite the absence of an up-to-date stock-taking of NCSDs on the global scale,⁴⁷ the challenges they face are relevant for all countries today. The Annex to this chapter provides an overview of selected studies that have examined NSDCs since the Earth Summit in 1992.

The composition of NCSDs usually reflects the characteristics of the political system and/or culture in which they exist.⁴⁸ In general, the more the NCSD is dominated by the government, the more it turns out to be a “communication platform”, used to communicate government policy to a range of stakeholders. Conversely, more independent NCSDs often tend to play a more advisory role in the decision-making process.

The extent of stakeholder engagement can vary from: (1) communication and awareness raising; to (2) consultation; to (3) involvement in decision-making; to (4) involvement in various parts of implementation and progress reviews.⁴⁹ The level of stakeholder engagement—and a government’s attitude toward such engagement—has a significant impact on the effectiveness of NCSDs and is often reflected in the resources that are provided to NCSDs.⁵⁰ Table 1 provides a summary overview of potential advantages and drawbacks of specific types of NSDCs, as well as lessons learned to make them more effective.

NCSDs can serve as platforms for dialogue between governments and all relevant stakeholders, in a form that usually encourages open and respectful debate.⁵¹ At the same time, NCSDs and other multi-stakeholder processes can also be dominated by specific interest groups, resulting in lack of accountability and lack of ownership. Potential solutions can include: transparency about roles, rights and responsibilities of participants and managing of expectations of what participation entails (e.g. information, collaboration or co-decision); having procedures in place to balance vocal minorities and silent majorities; setting rules for inclusion and exclusion of actors; as well as organizing how to codify agreement.⁵²

The mix of experts represented in NCSDs is variable. Participation of senior business leaders with sustainability interests and concerns is found to have worked well in a number of cases. Senior scientists, economists or other intellectuals with good practical experience and networks have provided added value in many cases⁵³. Adding an expert-type scientific body can potentially provide a more

deliberative setting, rather than the negotiation-style often seen in representative bodies.⁵⁴ For example, the Finnish National Commission for Sustainable Development (FNCSO), the longest-standing sustainable development council of the representative style, has added an independent panel of scientific experts in the early 2014. The expert panel scans the main obstacles and research concerning sustainable development, raises questions that should be taken into discussion and gives input to the work of the FNCSO. It also evaluates the implementation process of society's commitment to sustainable development and gives advice for its development.

Regarding oversight of Councils, some researchers see having leadership for sustainable development at the highest level (e.g. reporting directly to the Head of Government) as the most desirable arrangement,⁵⁵ as high-level leadership can foster horizontal coordination within the government, including for budgetary processes. High level representation can help integrate goals and objectives throughout the policy management cycle and among different sectors, as ministries tend to comply with executive orders from the highest national offices.⁵⁶ In addition, direct linkages between NCSDs and key decision makers increase the effectiveness of NCSDs.

Table 4-1: Overview of strengths and challenges of NCSDs

Composition	Strengths	Challenges	Lessons learned
Government representatives	<ul style="list-style-type: none"> • Greater influence over policy, even potentially having legislative powers • Strong leadership • Greater resources to implement strategies • Higher public profile 	<ul style="list-style-type: none"> • Potentially less independent and objective • Higher risk of being influenced by political interests • Not necessarily conducive to long-term thinking • Can result in lower levels of ambition 	It is important for such ministerial NCSDs to ensure that they have access to objective, evidence-based information and analysis about current sustainable development issues and trends, along with the impacts of continuing or altering current policies
Mixed membership	<ul style="list-style-type: none"> • Likely to be more representative • Can facilitate greater participation • Greater ability to draw on a wide range of opinions and expertise • Likely to lead in more progressive recommendations 	<ul style="list-style-type: none"> • Dominance of government voices over those of stakeholders • Difficulty to avoid deadlock and producing coherent messages in a timely manner • Difficulty avoiding silo thinking and keeping track of the broader picture 	It is important to ensure: <ol style="list-style-type: none"> 1) adequate representation of key sectors; good representatives of business interests on NCSDs appear to be particularly important 2) that non-governmental representatives do not feel inhibited by the diversity and are able to speak up and participate freely 3) all need to be given access to information in order to make informed and significant contribution
Non-governmental and stakeholder representative memberships	<ul style="list-style-type: none"> • Independence enables thorough scrutiny of government policy and speaking out about perceived unsustainable policies and practices • Likely to be very representative and have strong connections to stakeholder networks at the subnational level • Can potentially call upon large public support base to provide legitimacy and help advocate for recommendations 	<ul style="list-style-type: none"> • Influence over decision-makers and policy • Having representatives of a high enough status and standing • Ensuring interests and expertise that go beyond environmental issues • Securing long-term funding 	It is important to ensure that <ol style="list-style-type: none"> 1) members' interests, experience and expertise cut across all dimensions of sustainable development; strong capabilities in the fields of science, environment and economic would help 2) they have a status and standing to be able to engage effectively with ministers and senior officials in a range of departments, such as economic, finance, industry, social affairs, planning, environment

Source: Authors' elaboration, based on Osborn et. al., 2014.

4.4 Parliaments

As legislative bodies, parliaments are very important for the implementation of the 2030 Agenda and SDGs. Whichever form they take, parliaments execute three basic functions: representation, legislation, and oversight. Parliaments represent their respective constituencies; as part of their legislative duties they debate and approve legislation and in their oversight capacity they oversee the execution of these laws, national policies, and strategic plans. In turn, governments are expected to report back to parliaments, which have at their disposal evaluations and assessments from bodies such as audit institutions. While countries differ in their parliamentary systems,⁵⁷ all of them require parliamentary approval for legislation pertaining to the SDGs.

In looking at the contribution of institutions in leaving no one behind, it is relevant to make the distinction between inclusiveness *of* institutions, and inclusiveness *through* institutions. The former refers to whether institutions themselves are designed in a way that is conducive to inclusive representation and voice of all sections of society (or all countries). Representation is most inclusive when it encourages marginalized groups to express their perspectives.⁵⁸ Parliaments constitute an arena in which people's representatives can use language both to comment on the nation and try to shape it. When attempting to address a social inequity, for instance, a parliament can enlist culture, race, ethnicity, and similar identity categories.⁵⁹ Insofar as any group's distinctive concerns are not included, the parliamentary process itself may fail in its representative function.⁶⁰ Parliaments, as the most representative decision-making bodies, should normally aim to mirror the diversity of the society outside. This involves trying to ensure that all groups are represented, and that each group is represented more or less proportionally to its share of the general population.

In turn, inclusiveness through institutions refers to whether institutions through their actions directly support or enable inclusive outcomes that advance the common good as opposed to particular interests. In the case of parliaments, this means examining both how parliaments themselves are inclusive in their representation of all segments of society, including of marginalized groups, and how, when adopting legislation, they take into account the views, interests and needs of these groups. For example, parliaments are in a unique position to enact legislation to ensure that gender-based discriminatory norms and practices are eliminated, foster women participation in decision-making processes at all levels, and ensure equal access to resources such as health,⁶¹ education,⁶² economic resources,⁶³ private property,⁶⁴ and new technology,⁶⁵ all of which are specifically highlighted in the targets of the SDGs.⁶⁶

In order to illustrate how parliaments can foster these two dimensions of inclusiveness, this chapter looks specifically at four categories of persons in vulnerable or marginalized situations: women, indigenous peoples, persons with disabilities, and children and youth. These four groups are chosen as examples because they have received consistent attention from the institutional literature.

4.4.1 Women and girls

Promoting gender equality has been recognized as a priority for development for a long time,⁶⁷ and it is a key prerequisite for the success of the 2030 Agenda.⁶⁸ Parliaments are in the unique position to enact binding legislation within their sovereign limits to ensure that gender-based discriminatory norms and practices are eliminated. When women are denied participation in decision-making processes, it has been observed that they also have reduced equal access to resources such as health,⁶⁹ education,⁷⁰ economic resources,⁷¹ land,⁷² and new technology,⁷³ among others. Women and girls constitute approximately half of a country's population and their participation in parliaments is critical. Legislatures with more female parliamentarians are more likely to have an impact by adopting policies benefiting women and promoting gender equality.⁷⁴

A way to achieve higher women's participation is through gender based quotas in Parliaments, which have gained significant prominence since the adoption of The Beijing Declaration and Platform for Action at the United Nations Fourth World Conference in Beijing in 1995^{75, 76} as well as the Committee on the Elimination of Discrimination against Women's general recommendation No. 25 (2004) on special temporary measures, including quotas. Since the Beijing World Conference, States have increasingly adopted quotas to boost women's participation, counter discrimination and accelerate the slow pace at which the number of women in politics is rising. These measures are meant to correct some of the obstacles, especially institutional and systemic barriers that still prevent women's equal access to politics.⁷⁷

To varying degrees and subject to differing national situations, gender quotas in Parliaments have specified the rules⁷⁸ and procedures for selecting women candidates,⁷⁹ promoted higher similarity and a better sense of connection between voters and their legislators⁸⁰ (age, gender, ethnicity etc.), who act on behalf of women and their concerns.^{81, 82}

In the 1960s, less than 0.6% of legislators globally were women,⁸³ whereas as of 2015 that percentage has risen to 22.1%.⁸⁴ This increase is particularly prevalent throughout the Africa region, where over 25 percent of parliamentarians are women in 17 countries. It is important to note that these gains have generally been more rapid in developing countries than in developed countries.^{85, 86, 87} Recent gains are largely attributed to opportunities created during political transitions, pressures from women's movements

Box 4-1: The Rwandan Parliament

Rwanda has the highest representation of women in parliament of any country in the world, at 63.8%. In 2003 Rwanda constitutionally mandated government-wide gender quotas reaching all branches of government as well as all levels of government administration. The constitution states that a minimum 30% of women are required “in all decision making bodies” in the government.

Rwanda was one of the first countries in the world to craft and pass anti-Gender Based Violence legislation. The GBV bill eventually became law in 2008 and added important protections to women’s, as well as children’s, rights and made domestic violence, including marital rape, illegal under Rwandan law.

This achievement was achieved through constitutional gender quotas, transitional governments and strong institutional support from women’s civil society, which had become reliable pillars of the community in post-genocide Rwanda.

Source: Gretchen Bauer, Jennie E. Burnet 2013.

and civil society, and the evolving norms regarding the incorporation of women into politics.^{88, 89} Also critical is the support of governing parties in enacting gender-related legislation and quotas.⁹⁰ Despite progress made, if adopted in isolation, quotas are usually not enough to ensure equality. Moreover, they require adaptation to the local context.⁹¹ Quotas for women need to be coupled with other measures to create an enabling environment for women to participate. Particularly, the positive impact of increasing women’s representation in public and political life will not be felt if the women who gain access are not also empowered to actively participate in the discussions and exercise influence in decision-making.^{92, 93}

4.4.2 Indigenous Peoples

Indigenous peoples are characterized by their specific relationship to the land or territory they inhabit, and their distinct culture often inclusive of language, practices, and art.⁹⁴ There are more than 370 million self-identified indigenous people in some 70 countries around the world. In Latin America alone there are more than 400 groups, and an estimated 705 groups in Asia and the Pacific. Worldwide, they account for 5% of the population, but represent 15% of those living in poverty.⁹⁵

Since the mid-20th century, indigenous peoples have struggled to obtain recognition of their socio-cultural specificities and consequent rights before States.⁹⁶ As such, the issue of self-determination has been at the forefront of the relationship between the state and their indigenous communities.^{97, 98} Indigenous self-determination mainly refers to political participation and is explicitly limited by the states’ right to territorial integrity,⁹⁹ although some external aspects of self-determination can still be in place, such as international representation and cross-border cooperation.¹⁰⁰ The connection between the right of self-

determination and the right of political participation is indivisible, and has been recorded by the UN Human Rights Committee.¹⁰¹

As such, representation in parliament is a powerful symbol of indigenous self-determination and inclusion.^{102, 103} The first step is to officially recognize the community as indigenous. Affirmative action in terms of preferential policies is a strategy that is commonly used to tackle the structures of inequality.¹⁰⁴ Measures to improve indigenous participation include periodic reviews of the electoral system and the introduction of quotas, promotion of a more active indigenous role in political parties, employment and training opportunities for indigenous peoples in political bodies, veto powers for indigenous communities, indigenous direct input into legislative and policy processes, enhancement of indigenous participation in local government and youth participation in political processes¹⁰⁵ through legislation, capacity building activities and education.

In some cases, indigenous populations have established their own parliaments or councils, which do not exercise political or legislative power, but rather act as a consultative body. A prominent example is the case of the Sami people residing in Norway, Sweden and Finland. Conversely, New Zealand has the longest history – over 140 years - of indigenous self-representation in a national legislature (Box 4.2).¹⁰⁶ Other countries do not recognize the rights of indigenous peoples within their borders, and have therefore no specific provision for their political representation in the national parliament. While countries differ in their approaches towards indigenous peoples, it is important for the academic community as well as civil society experts to continue to assess methods for ensuring long-term engagement of the various indigenous populations and their meaningful contribution to the 2030 Agenda.

Box 4-2: The Maori case

The Maori Representation Act of 1867 introduced a dual constituency system in New Zealand, where representatives to the parliament are elected from two sets of single member electorates, one for persons of Maori descent and the other for those of European descent - nowadays referred to as general electorates. Electoral reform in the 1990s succeeded in furthering Maori representation by allowing the number of Maori electorates, which had remained fixed at four, to vary on the basis of enrolment; and by introducing proportional representation. Since the party list determines the overall allocation of seats in parliament, parties have an incentive to appeal to Maori voters despite the segregation of their constituency votes. Therefore, such a system enables the minority to have a guaranteed level of descriptive representation without risking loss of substantive influence. The adoption of a proportional party list electoral system together with the dual electorates has succeeded in increasing Maori representation dramatically.

Source: Banducci et al., 2004.

4.4.3 Persons with Disabilities

Over a billion people are estimated to live with some form of impairment.^{107, 108} They remain among the most marginalized in most societies due to a lack of disability sensitive and responsive policy interventions, barriers like stigma and discrimination as well as inaccessible physical and virtual environments, such as communication devices and transportation methods, and segregated educational institutions.¹⁰⁹ Accessibility and inclusion are fundamental human rights for persons with disabilities, and are critical to empowering persons with disabilities to live independently, be included in their communities, and to participate in and make contributions to society and development on an equal basis with others. In essence, the issue of accessibility and inclusion is a critical starting point that Parliaments and the global community have to take up by in order to incorporate persons with disabilities and their needs.

Parliaments have been critical channels for promoting the rights for persons with disabilities through implementing frameworks such as the Americans with Disabilities Act of 1990 in the United States of America and the Disability Discrimination Act of 1995 in the United Kingdom. One important achievement at the global level was the adoption of the United Nations Convention on the Rights of Persons with Disabilities,¹¹⁰ which was ratified by 164 countries and one regional group, the European Union, as of June 2016.¹¹¹ Persons with disabilities have also benefited from the changing policy trend towards the removal of legal, institutional and physical environment barriers, expansion of access to opportunities for participation, including in public services, increased social protections, and improved recognition of people with disabilities in social programmes.¹¹² For example, 155 countries mandate cash benefits to persons with disabilities that serve as income replacement or supplement.¹¹³ However, narrowly focusing on the 'letter of the law' may create a basic level of rights; but more must be done to instil a culture of fair and equitable treatment of persons with disabilities and facilitate full and

active participation by persons with disabilities in society in a meaningful manner.^{114, 115, 116, 117}

4.4.4 Children and Youth

The term "youth" usually refers to people from 15 to 24 years of age. Children (defined as all under the age of 18)¹¹⁸ have the right to express their views freely on matters affecting them.^{119, 120} However, voting, which is often the main venue to exert influence on a political process, is not an option normally open to children¹²¹ given that the vast majority of countries have legislation in place setting the age of 18 as threshold for voting.^{122, 123, 124} Therefore, despite advances in their rights to political participation, citizenship, and voice, it remains the case that a third of humanity around the world who are under 18, exercise relatively little political power, whether in electing representatives, influencing laws, or shaping policies. In addition, not all young people, even though they are old enough to vote, choose to engage with formal political processes.^{125, 126} The general downward trend in voter registration among younger age cohorts points to the fact that young people are increasingly looking to social movements and community organisations as platforms for their political interests and action. Whether this is a symptom of exclusion, or just a different form of participation, is debated.¹²⁷

In terms of participation in formal political processes, young women appear to be even more disadvantaged in terms of opportunities to be elected. Some of these variations can be explained in relation to electoral systems, youth quotas, eligibility ages and levels of women's representation (as a measure of the broader inclusiveness of a parliament).¹²⁸ Alternative measures for increasing youth political participation include, for instance, participation in government sponsored advisory roles, in youth parliaments¹²⁹ and in roundtable discussions, as well as less formal activities such as political fundraising, volunteer work, protest movements and youth groups.¹³⁰ At least thirty countries have some kind of non-adult parliament structure, whether nationally or in cities,

villages, or schools. These include India, Sri Lanka, Norway, Finland, Germany, Slovenia, Bolivia, Ecuador, Brazil, Nigeria, Zimbabwe, Congo, Burkina Faso, Liberia, New Zealand, the UK, Scotland, and a Children's United Parliament of the World (See box 4-3 for examples).¹³¹

Municipal plans of action for children, designed to translate commitment into specific activities, are often adaptations of national plans of action—as in the ones in Honduras undertaken by 293 municipalities.¹³² Children's participatory budget councils, such as the one in Barra Mansa, Brazil, can also foster citizenship and be real fora for public participation in defining and implementing public policies.¹³³ Youth and children development agendas developed by governments, such as the ones developed by New Zealand, can also be potentially effective tools for promoting youth participation, among others, through advocacy, services, and governance.

4.5 Conclusion – Considerations for Policy Makers

Institutions are established by people to guide the pursuit of equitable and equal fulfilment of their human rights and needs. In turn, institutions shape all human interaction, including in the family, community, and political and economic spheres, influencing how societies develop. The patterns of behaviour generated by institutions can be either positive or negative for development outcomes and for inclusiveness. The 2030 Agenda and the SDGs call for inclusion and participation in the social, political and economic spheres of all societal groups. This chapter looked at how two types of institutions - NCSDs and Parliaments – can be active promoters of inclusion.

Research reviewed for the report suggests that, if provided with adequate resources, NCSDs can be effective mechanisms for stakeholder participation and engagement

across the whole policy cycle, to: inform and educate the public at large on sustainable development related topics; stimulate informed public debates; engage key stakeholders in formulating policy recommendations; and involve stakeholders in various parts of implementation and progress reviews. The review in this chapter is limited to a certain extent by the lack of empirical data, even though dispersed data do exist and would merit further study. The limited attention given to NCSDs by academia is an example of an area where research could be encouraged.

With respect to parliaments, the chapter looked specifically at women, indigenous peoples, persons with disabilities, and children and youth. Research reviewed for the report suggests that progress has been made with respect to the representation of these groups in national parliaments. However, gaps still exist. Similarly, while progress has been made in terms of codifying the rights of marginalized groups, there is still a long way to go in this respect, and parliaments will have a key role to play in ensuring that no one is left behind. Other marginalized and vulnerable groups would also deserve attention in the context of a more comprehensive review.

In order to improve the science-policy interface on institutions for sustainable development, it will be important to collect evidence on other types of institutions and how they can foster inclusiveness. Examples include Local Agendas 21 and other participatory processes at the local level; mechanisms for access to information and access to justice; norms and standards in various areas; and mechanisms to represent future generations in policy-making.¹³⁸ Conversely, it will be important to collect evidence on what combination of institutions and institutional features are successfully used to address specific goals and targets, including those related to inclusiveness. This should be a critical component of future Global Sustainable Development Reports.

Box 4-3: Examples of youth participatory mechanisms

An example of effective children's parliament is the Bal Sansad Children's Parliament in Rajasthan, India, which brings together children from different villages to discuss and deal with common concerns such as schooling and all aspects of village life.¹³⁴ Additional examples of children being given some form of representative voice in governance include: the 2003 South African "Children in Action" project to include children's participation in parliamentary hearings and public debates; the 2004 appointment of four Children's Commissioners in the UK to safeguard and promote children's rights in legislation and policy; the Israeli Knesset regular invitation to children to participate in its child-related committees; and the Rwandan annual National Summit for Children and Youth around a particular child-related theme.¹³⁵

The Smithston Student Borough Council and Baston Young People's Town Council in the UK, and the Association Nationale des Conseils d'Enfants et des Jeunes found in French towns are also examples of youth participatory mechanisms.¹³⁶

"Urban consultations" between urban administrations and children and youth, like the ones undertaken in the cities of Cotacachi, Ecuador, Barra Mansa and Icapuí, Brazil, and Ciudad Guyana, Venezuela, have also been successful mainly due to the commitment of the municipal authorities to their success and political, economic and social viability.¹³⁷

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IDENTIFICATION OF EMERGING ISSUES FOR SUSTAINABLE DEVELOPMENT

5.1 Introduction

The Global Sustainable Development Report (GSDR) is a United Nations publication aiming to strengthen the science-policy interface at the High Level Political Forum (HLPF). Science-policy interfaces refer to the many ways in which scientists, policy-makers and other stakeholders link up to communicate, exchange ideas and jointly develop knowledge to enrich policy and decision making processes and research.¹ The 2015 GSDR underlined the importance of utilizing these linkages to identify emerging issues across the whole spectrum of sustainable development, including its social and economic dimensions.² While many approaches exist for identification of emerging issues, common features include the involvement of experts and formalized processes drawing on scientific evidence, assessments, and projections.

The science-policy interface involves the exchange of information and knowledge leading to learning and, ultimately, changes to decision-making and behaviour. It can provide a variety of functions at different stages of the policy and decision-making process. For instance, scientific advice can steer public attention to issues that threaten human well-being and that require policy intervention. Many environmental and health problems (e.g. climate change, malaria, HIV/AIDS) were brought to the forefront of political attention through a process of awareness creation relying on scientific expertise. Alternatively, in the absence of public concern and before issues enter the policy cycle, scientific expertise can be used to bring them to the attention of policy-makers, provide problem definition and assess the potential impact of different policy options. In general, it could be said that it is crucial to inform policy and decision makers about new and future opportunities as well as threats and have them prepare for slow changes and sudden shocks.

Policymakers are exposed to a broad range of analyses, rankings, and advice concerning emerging issues, prepared from a multitude of perspectives. However, the available material varies widely in terms of scales – geographical and temporal – and in the thematic coverage of issues. As such, it is not readily accessible for policy-makers in the HLPF. There is thus a need to systematize the existing material, informed by a sustainable development perspective. The Secretary-General's 2016 report on follow-up and review at the global level highlights that a critical mandate for the HLPF is to address new and emerging issues.³

Following the initial consideration of emerging issues in the 2014 and 2015 Reports, it was felt that one problem was the relative absence of frameworks for: first, systematically identifying a range of issues for possible consideration by policymakers; and second, categorizing and presenting them. The aim of Chapter 5 is to give an overview of existing approaches to identification of emerging issues for sustainable development, as well as to provide and demonstrate a possible approach to identify emerging issues for future Global Sustainable Development Reports. The first part of the chapter aims to contribute to the policy discussion by: identifying what an emerging issue is, outlining criteria and introducing “scanning” as major approach for finding emerging issues; and providing a possible framework for categorizing emerging issues. It also presents a sample of emerging issues from a variety of sources. These sources were used to provide a broad overview of the emerging issues that can be considered by policy makers. The second part of the chapter focuses on the expert assessment of emerging issues which was conducted as an exercise in order to explore and apply a new approach to the identification of emerging issues for sustainable development.

Table 5-1. Criteria for identifying emerging issues

Criteria	Explanation
<i>Risk assessment</i>	
Probability of occurrence	Likelihood of occurrence
Impact/extent of potential damage	Impact on society, economy, environment
<i>General/cross-cutting</i>	
Persistence	Short to long-term effect, long decay in environment
Irreversibility	Damage/harm cannot be undone
Latency/delayed response	Gap between causal event and damage/harm
Ubiquity	Geographic (local to global), across multiple dimensions of sustainable development
Novelty	New to policymakers, departs from prevailing scientific understanding
Potential for mobilization	Degree of political relevance
Plausibility	Clear cause-effect links, authoritative sources, evidence-based
Resolvability	Perceived as conducive to human intervention, within existing paradigms of action
Priority	Importance in terms of social and cultural norms, impact on already vulnerable/marginalized

Source: Adapted from WBGU (1998)⁵; Amanitidou et al (2012)⁶

Box 5-1: Emerging issue and newness

Recognition as 'emerging' is based on 'newness', but not necessarily issues that are unheard of or that come as a surprise. Newness could be the result of:

1. new scientific knowledge, which could be in form of new data, evidence, theory or model;
2. new technological development;
3. new scales or accelerated rates of impact;
4. a heightened level of awareness; and
5. new ways of responding to a known issue.⁴

5.2 Identifying emerging issues

There are numerous ways in which the idea of 'emerging issues' pertinent to policy makers and the sustainable development agenda could be conceptualized (See Box 5-1). The broad scope of sustainable development suggests that virtually any social, economic or environmental process or challenge amenable to scientific understanding may potentially be relevant. Emergence, meanwhile, could signify the novelty or intensification of some of those issues, fresh understanding of their causes or consequences, the development of new management options, or the identification of issues that have gone previously unrecognized. The inherently subjective process of identifying emerging issues can, however, be guided by criteria, selected with a view to the particular field of interest, e.g. the global environment.

For instance, as illustrated in table 5-1, a common starting point is an assessment of probability and impact, with additional criteria catering for more fine-grained analysis. Thus an assessment of potential persistence of an effect could be of importance in considering an emerging issue in the environmental domain. It must also be recognized that how – and by whom – an issue is perceived as emerging will make a difference, not least to effective policy action. Scientific findings and support are necessary, but whether an issue comes to the fore will also depend on political processes and social norms.

The process of identifying emerging issues can proceed in a number of ways, but a common starting point is “scanning” for issues across a range of sources, informed by the purpose of the exercise. Horizon scanning is defined as “the systematic examination of potential (future) problems, threats, opportunities and likely future developments including those at the margins of current thinking and planning. Horizon scanning may explore novel and unexpected issues, as well as persistent problems, trends and weak signals”.⁷ Weak signals are the first sign of emerging issues and the indicators of possible change.⁸

More broadly, scanning serves a policy development function by informing scenario and other future-directed exercises, and by emphasizing the creation of networks and knowledge flows between organizations.⁹ Figure 5-1 situates the “scanning” in a broader context of future-oriented tools for policymaking.

Exploratory scanning focuses on compiling potential emerging issues from a wide variety of data from different sources, while an issue-centered approach concentrates on identifying core documents that describe substantial parts of potential issues. So as to avoid a one-dimensional view on emerging issues, it is advisable to consult as wide as possible a variety of information sources, taking into account the scope and purpose of the exercise. The role of

human perception, especially expert opinion, plays a key role in many approaches to identifying emerging issues. More broadly, the framing of issues – guided by shared assumptions and worldviews – influences which issues are labelled as emerging.¹¹

Even a guided scanning process is likely to generate a large number of issues. To identify issues that are appropriate for policymakers at the global level, some form of filter can help to screen out issues of primarily local or national significance. Adapting the “global filter” proposed by the WGBU¹² for environmental issues, the following questions could be useful in filtering emerging issues for consideration by policymakers at the international level in the HLPF:

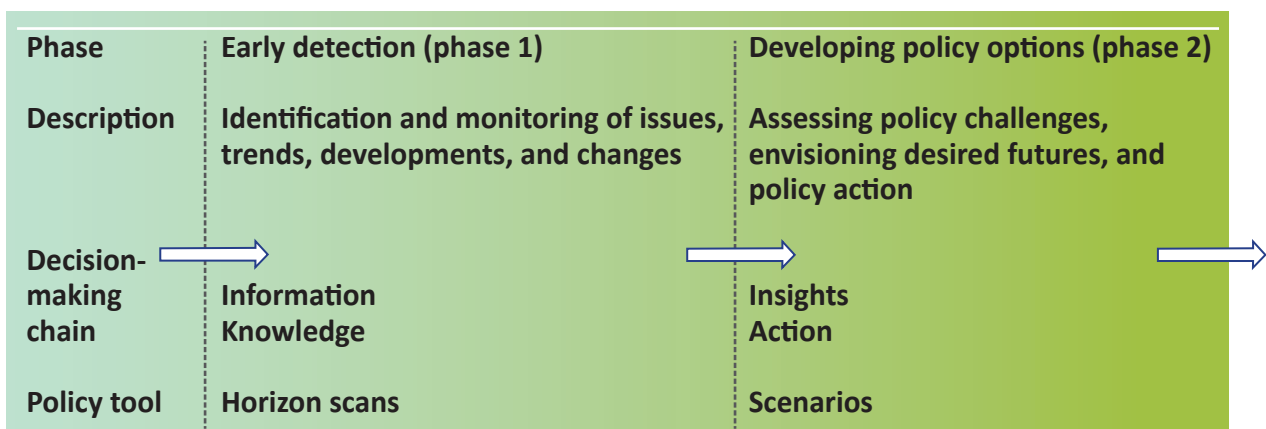
1. Does the issue in question relate closely to the Sustainable Development Goals?
2. Is the issue a potential threat or opportunity of global, or at least international relevance?
3. Does management of the risk or harnessing of the opportunity depend on international action and cooperation?
4. Is the issue expected to persist (non-transient) and/or does it have a clear increasing trend?

Figure 5-2 sets out in schematic terms the process of scanning for issues, with the application of a “filter” to sift for issues of potential interest to policymakers, in this case the HLPF.

5.2.1 Frameworks for emerging issues

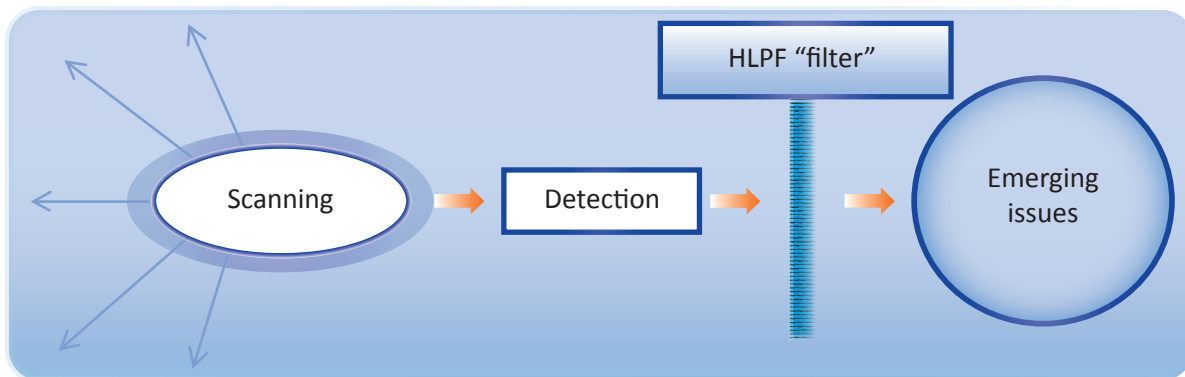
Following the exploratory scanning of issues, the next step usually involves clustering or categorizing the issues in manner that facilitates analysis and insight^{13, 14}. Various frameworks can be used – what works will depend on the context and overall goal of the research. Ideally, the framework should be reasonably flexible. In order to

Figure 5-1: Simplified phases of a foresight process



Source: adapted from Habegger (2009).¹⁰

Figure 5-2: Schematic representation of a process for identifying emerging issues in the HLPF



Source: Authors' elaboration.

understand which framework is most suitable for the sustainable development context, emerging issues from a selection of assessments and reports – see table 2 below – were categorized in accordance with three frameworks:

1. STEEP framework: Social, Technological, Economic, Environmental and Political;
2. “Kates” framework: areas and issues typically covered in definitions of “sustainable development” in the literature;¹⁵
3. DPSIR framework: Driving Forces-Pressures-State-Impacts-Responses.¹⁶

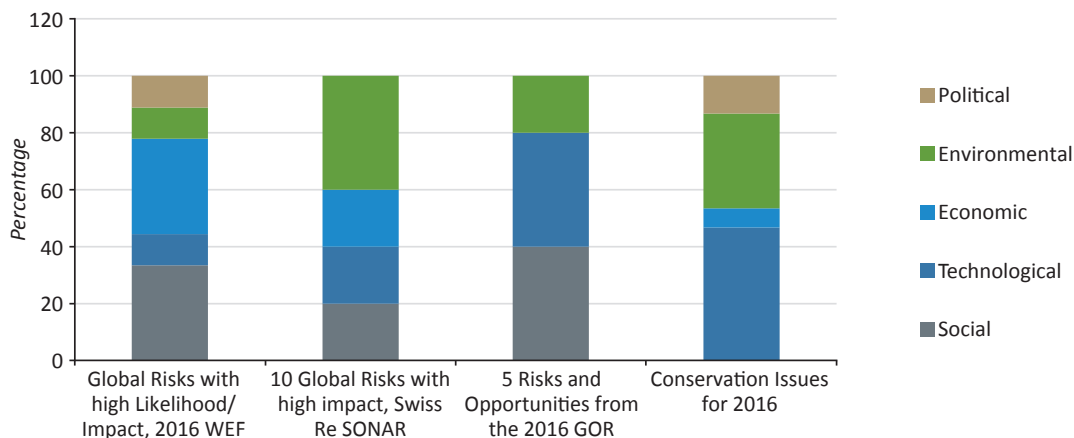
STEEP framework is the most straightforward taxonomy for obtaining a broad categorization of potential emerging issues that is readily applicable to a number of disciplines and modes of analysis. DPSIR is a causal framework for describing the interactions between society and the environment and, as a result, is best suited to environmentally-related emerging issues. The Kates et al framework has a broader approach, which includes six categories: Nature, Life support, Community, People, Economy, and Society. For purposes of an initial clustering effort, the STEEP framework proved to be more suitable than the other two frameworks. This is by no means to

claim that it is inherently superior; rather, that it proved more capable of being applied with reasonable ease and consistency to the rather broad set of issues in question. Additionally, categories used in the STEEP framework were familiar to different interest groups.

Table 5-2 illustrates the categorization of emerging issues identified in a four reports and assessments, prepared from different perspective and for different audiences. In this sample, social and political categories had the lowest share of issues; however, the distribution of issues is sensitive to the type and number of reports from which they are drawn. For example, the large number of technology-related issues listed in Table 5-2 reflected one report – Conservation Issues for 2016 – used during the scanning phase (Figure 5-3). Moreover, some of the emerging issues could fall into several categories – issues that were sorted into social, technological, economic or political categories could also fall into the environmental category.

In the presentation of possible emerging issues, it may be useful to further group them in accordance with a rough timeframe. Table 5-3 illustrates this with issues taken from the WEF and SAB reports. The introduction of a temporal dimension for emerging issues can assist in clarifying

Figure 5-3: Percentage of Emerging Issues by category and data sources



Source: Authors' elaboration.

Table 5.2: Emerging issues identified in selected prominent reports and assessments

Emerging Issues Source	Social	Technological	Economic	Environmental	Political
"Global Risks" with highest average impact and likelihood (World Economic Forum, 2016)	<ul style="list-style-type: none"> • Large-scale involuntary migration • Profound social instability • Water crises 	<ul style="list-style-type: none"> • Cyberattacks 	<ul style="list-style-type: none"> • Fiscal crises in key economies • Unemployment and underemployment • Asset bubble 	<ul style="list-style-type: none"> • Failure of climate-change mitigation and adaptation 	<ul style="list-style-type: none"> • Interstate conflict
10 Global Risks in Terms of Impact in the next 3 years (Swiss RE, 2015)	<ul style="list-style-type: none"> • Lifestyle drugs • Rising pandemic risk 	<ul style="list-style-type: none"> • Predictive maintenance • The dangers of LED light 	<ul style="list-style-type: none"> • De-globalisation • The great monetary experiment 	<ul style="list-style-type: none"> • "Super natural" catastrophes • Brazilian drought • Wildfires • Fossil fuel management 	
Risks and Opportunities (Global Opportunity Report, 2016)	<ul style="list-style-type: none"> • A generation wasted: <ul style="list-style-type: none"> -The digital labour -Market -Closing skills gap • Global food crisis: <ul style="list-style-type: none"> -New diets -Smart farming 	<ul style="list-style-type: none"> • Resistance to life-saving medicine: <ul style="list-style-type: none"> -Antibiotic-free Food -Precision treatment • Accelerating transport emissions: <ul style="list-style-type: none"> -Flexibility mobility -Crowd transport 		<ul style="list-style-type: none"> • Loss of ocean biodiversity: <ul style="list-style-type: none"> -Regenerative ocean -Economy -Closing the loop 	
Horizon Scan of Global Conservation Issues for 2016 (Sutherland et al. 2016)		<ul style="list-style-type: none"> • Artificial Intelligence • Electric Pulse Trawling • Osmotic Power • Satellite Access to Shipborne Automatic Identification Systems • Passive Acoustic Monitoring to Prevent Illegal Activity • Synthetic Body Parts of Endangered Animals • Artificial Glaciers to Regulate Irrigation 	<ul style="list-style-type: none"> • Changing Costs of Energy Storage and Consumption Models 	<ul style="list-style-type: none"> • Managed Bees as Vectors • Increasing Extent of Construction of Artificial Oceanic Islands • Increasing Aquatic Concentrations of Testosterone • Effects of Engineered Nanoparticles on Terrestrial Ecosystems • Invasive species as Reservoirs of Genetic Diversity 	<ul style="list-style-type: none"> • Ecological Civilization Policies in China • Unregulated Fisheries in the central Arctic Ocean Threaten Expanding Fish Stocks
Top Challenges for the Future of Humanity and the Planet identified by the UN Secretary-General's Scientific Advisory Board (UN-SAB, 2016)	<ul style="list-style-type: none"> • Ensuring investment, as a fraction of GDP, in basic research and science education • Providing drinking water for all 	<ul style="list-style-type: none"> • Emissions free technology: changing the fossil fuel paradigm 	<ul style="list-style-type: none"> • One ocean, many countries: building a "Blue economy" sustainably 	<ul style="list-style-type: none"> • Addressing threats to biodiversity and establishing a new paradigm for the global tropics • Putting in place a comprehensive strategy against infectious agents, including a global system for immediate response 	<ul style="list-style-type: none"> • Averting enormous human disasters through prediction • Finding solutions for a world overwhelmed by unequal resource use and continued population growth

Sources: World Economic Forum¹⁷; Swiss Re SONAR¹⁸; UN Global Compact¹⁹; Sutherland et al.; UNESCO contribution to GSDR 2016.²⁰

institutions and policy-making levels that could have a potential interest in an issue. Results can be presented in the format of a table, where the STEEP framework can be used again to organize emerging issues by context and time periods.

5.2.2 Identifying emerging issues from a variety of sources

In addition to the reports above, the preparation of the 2016 GSDR includes material from a range of sources: (a) selected issues from emerging issue identification mechanisms within the UN system; (b) a snapshot of emerging issues and research priorities identified by national academies of sciences; (c) selected issues from leading academic journals; and (e) a summary of relevant points from crowdsourced science briefs.

Global UN initiatives

A number of UN entities and agencies engage in emerging issues identification processes and related exercises. In some cases, such processes have long standing, while others are more recent. In light of the 2030 Agenda, it is anticipated that more UN agencies will focus on identifying emerging issues for sustainable development. The following are some examples of emerging issues processes and exercises from United Nations entities. A selection of these processes is summarized in Annex 1. For instance, UNEP provided information on emerging issues identified by regional processes, drawing on the criteria outlined in Box 5-2. Additionally, UNESCO provided a contribution for the GSDR 2016 with the results of the research on top challenges for the future of humanity and the planet identified by the UN Secretary-General's Scientific Advisory

Box 5-2: UNEP SP7 Emerging Issues Project

The project was focused on definition of emerging environmental issues and processes for identifying and selecting emerging issues at the regional scale. From the perspective of the regions, emerging issues must be critical to the sustainable development of the region of focus and recognized as very important in the region, but has not yet received adequate attention from the policy community. It should require immediate priority action by decision makers as well as other stakeholders and actors in the region and must be evidence-based, including scientific and traditional sources of knowledge, recognized as 'emerging' based on 'newness'.

Source: UNEP.

Board conducted using Delphi method (See Box 5-3 - the outcome of the research is presented in Table 5-2). Intergovernmental Oceanographic Commission (IOC) of UNESCO provided a list of emerging issues in the particular field as well.

National Academies of Science

National academies of science play a significant role in the academic world by coordinating and sometimes defining research priorities in all scientific fields of interest and importance to a particular country. National academies are also often charged with providing independent, objective advice to their governments on matters related to science and technology. Membership in a national academy of

Table 5-3: Emerging issues and indicative timeframes

	STEEP		Anticipated Impacts
	0-2 Years	2-5 Years	5+ Years
Social	<ul style="list-style-type: none"> • Violence 	<ul style="list-style-type: none"> • Profound social instability • Putting in place a comprehensive strategy against infectious agents, including a global system for immediate response 	<ul style="list-style-type: none"> • Ensuring investment, as a fraction of GDP, in basic research and basic science education • Providing drinking water for all
Technological	<ul style="list-style-type: none"> • Cyberattacks 	<ul style="list-style-type: none"> • Averting enormous human disasters through prediction 	<ul style="list-style-type: none"> • Emissions free technology: changing the fossil fuel paradigm
Economic	<ul style="list-style-type: none"> • Fiscal crises in key economies 	<ul style="list-style-type: none"> • Unemployment and under-employment • Asset bubble 	<ul style="list-style-type: none"> • One ocean, many countries: building a "Blue economy" sustainably
Environmental	<ul style="list-style-type: none"> • Emerging diseases 	<ul style="list-style-type: none"> • Water crises 	<ul style="list-style-type: none"> • Failure of climate change mitigation and adaptation • Addressing threats to biodiversity and establishing a new paradigm for the global tropics
Political	<ul style="list-style-type: none"> • Large-scale involuntary migration 	<ul style="list-style-type: none"> • Inter-state conflict 	<ul style="list-style-type: none"> • Finding solutions for a world overwhelmed by unequal resource use and continued population growth

Source: Authors' elaboration.

Table 5-4: Selected issues considered by national academies of sciences

Emerging Issues	The Royal Society UK	Hungarian Academy of Sciences	Academy of Sciences of Tajikistan	Brazilian Academy of Sciences	Slovenian Academy of Sciences and Arts	Cameroon Academy of Sciences
Social	Food and environmental security	Effects of labour market status and education on subjective well-being of youth in Europe	Improvement of quality of education	Neglected Diseases	State and vision of higher education in Slovenia New dictionary of Slovenian language	Agriculture for Improved Nutrition of Women and Children in Nigeria
Technological	Solar Geoengineering	Application and development of nuclear analytical techniques	Methods of prevention, diagnosis, and treatment of infectious diseases		Bio-robotics Risks of computing, artificial intelligence and internet	Anti-malarial Drug Resistance in Cameroon
Economic	Long-term Growth from Science and Innovation	International comparisons of product supply chains in the agro-food sectors: determinants of competitiveness & performance in EU and international markets	The economic mechanisms & development of market relations in Tajikistan			
Environmental	Resilience to extreme weather	Improved monitoring and forecasting of ecological status of EU inland waters by combining future Earth observation data & models	Monitoring of water resources and their integrated use	The Forest Code and science in Amazonia	Forest and wood	
Political	Joint action on disasters, development and climate change	Potentials and challenges of evolving border concepts in a post-Cold War world	S&T policies and politics	A State Policy for Science, Technology & Innovation	Establishment of court of honour in science ethics Ethics of public expression and hate speech System of evaluation of research work in Slovenia	Elements for a National Biotechnology Policy Framework for Cameroon

Source: Authors' elaboration, based on inputs from academies of sciences.

Box 5-3: Delphi Method by UN-SAB25

The Delphi method is used to distil knowledge and build reliable consensus among experts who may not be in the same geographical location. It involves structured, sequential questioning of a panel of experts, in this case members of the UN Secretary-General's Science Advisory Board (SAB), with controlled feedback. In round one of the Delphi study, twenty three big ideas that would have a global impact in addressing the implementation of the Sustainable Development Goals were submitted. In round two, Board members systematically assessed these ideas. The result was a list of top eight challenges.

Source: UNESCO

Box 5-4: Ancient grasslands at risk, William J. Bond

The problem of deforestation has led to efforts to identify areas suitable for reforestation, and large areas of open grassy vegetation have been identified as potential sites. However, recent research demonstrates that rather than being the degraded secondary products of deforestation, grasslands are often ancient and highly biodiverse. But it remains difficult to reliably distinguish primary and secondary grasslands on a large scale.²¹

science is among the highest honours a scientist can receive. Therefore, it was considered that national academies could be a useful source for information on emerging issues in science, potentially bringing in diverse national areas of emphasis.

The list of emerging issues contained in Table 5-4 is a snapshot of issues compiled from publically available reports and statements issued by national academies, as well, in some cases, from information provided directly by national academies following email request. It represents

a list of selected issues considered by some national academies of sciences sorted using the STEEP framework. From the selection of issues, it is apparent, at least from this sample of national academies, that they are addressing the kinds of issues falling within the domain of sustainable development – water, infectious diseases, resilience to extreme weather – as well as more “advanced” scientific enquiry, for instance in relation to artificial intelligence.

Issues from Leading Journals

In its simplest form, scanning for emerging issues can be based on a fixed set of authoritative, peer-reviewed academic journals.²² For the purpose of the GSDR, criteria for selecting articles of interest could include: major breakthrough in knowledge or technology, potentially high impact on sustainable development, global and long-term significance, greatly increased scientific interest in the issue, calling for or implying the need for policy action or for new sustainable business opportunities. Boxes 5 and 6 present two examples of topics highlighted in leading scientific publication that are potentially relevant for sustainable development in the future, beyond their intrinsic relevance within their field or discipline.

Box 5-5: Mastering the game of Go with deep neural networks and tree search, Silver et al. 2016

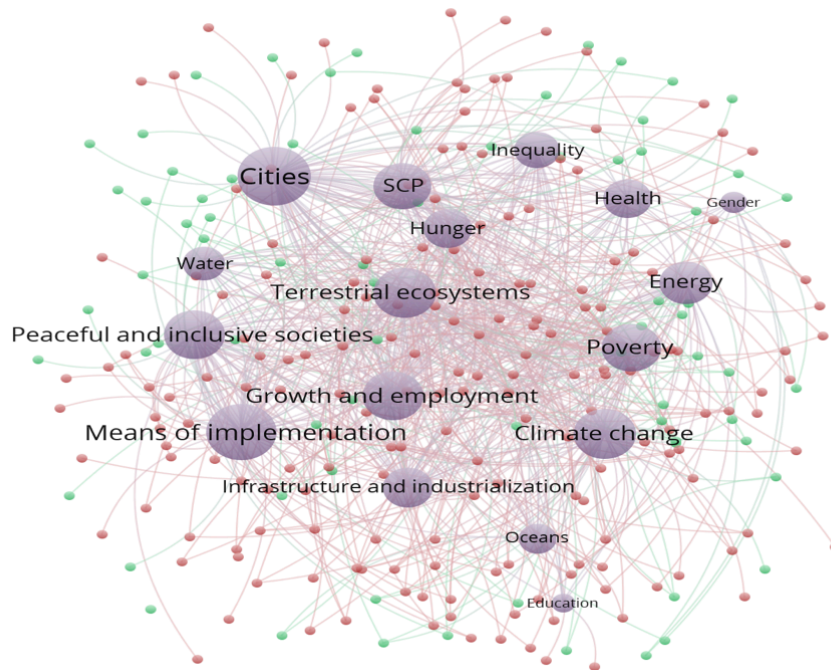
The game of Go has long been considered as the most challenging of classic games for artificial intelligence, due to the very large number of possible moves and the difficulty of evaluating board positions. It required a different approach to the one used in the IBM computer that famously beat the world's leading chess player in 1997. For the computer Go player, deep neural networks are trained by a novel combination of supervised learning from human expert games, and reinforcement learning from games of self-play. Since the publication of the study, the computer Go player beat the best human Go player in the world by 4 games to 1.²³

Table 5-5: Distribution of and sample issues from crowdsourced science policy briefs (2016)

Social	Technological	Economic	Environmental	Political
20 briefs	14 briefs	4 briefs	14 briefs	10 briefs
Urban health	Artificial intelligence	Green economy	Heat waves	Thematic reviews in the 2030 Agenda
Gender mainstreaming	Green infrastructure	Green jobs	Climate change & society	Regional collaborative environmental governance in China
Education for sustainable development	Big data: challenges and opportunities		Urban storm water: challenges and opportunities	Urban Sustainability Transformations in real life politics

Source: Author's compilation.

Figure 5-4: Overview of science briefs and their coverage of the SDGs



Note: Submitted briefs are labelled brown (2015) and green (2016) circles, which are connected to labelled circles. Size of nodes is proportional to the number of links.

Crowdsourced Science Briefs

Crowdsourced briefs are inputs received from the scientific community around the world, highlighting a specific issue, finding, or research with a bearing on sustainable development or the inter-linkages between them. The call for science policy briefs for the 2016 GSDR requested prospective authors to review up-to-date findings relating to a particular issue, address a single issue of importance, or present recommendations and solutions to a problem or challenge. The call – available in all six official languages of the United Nations – specifically stated that contributions from both the natural and social science communities and from all disciplines were highly valued and welcomed. Guidance to potential authors called for concise briefs (less than 1,500 words) that are factual and based on peer-reviewed literature. It was also recommended to highlight key messages from the current scientific debate for the attention of policy-makers.

The open call for science briefs resulted in over 70 submissions accepted from all regions of the world. The majority of briefs were written in English, although briefs were also submitted in Chinese, Portuguese, Russian, and Spanish. Most of the contributing scientists were affiliated with universities or research centres from developing and developed countries.

Table 5-5 illustrates some of the issues highlighted by the briefs by theme, using the STEEP framework introduced earlier. The largest share of the briefs related

to the social category, followed by technological, economic, environmental, and political issues. Even though this is a random collection of issues identified by various knowledge-holders, their consideration still bears merit as they may highlight emerging issues that would not necessarily have been identified through other processes.

Figure 5-4 illustrate diversity of the briefs submitted in response to the calls for the GSDR 2015 and 2016, by showing their coverage of the 17 SDGs and of the linkages among them.

The following section draws out some of the highlights from a selection of the briefs received for the GSDR 2016, including new and interesting findings. The content of other briefs is described in other chapters (Chapter 1, Chapter 2 and Chapter 3). In particular, a significant number of briefs were relevant to technology issues and are referenced in chapter 3.

A number of briefs examined emerging new paradigms necessary to enable transformative shifts to sustainable development that incorporate a wider understanding of social welfare (public health, happiness, quality of environment, literacy), differentiate between sustainable development and economic growth as measured by GDP per capita, and promote social reforms that reduce inequalities.²⁴

The broader institutional role that professions exercise in accomplishing change is important, since

delivering sustainability may involve challenging deeply institutionalized assumptions and practices in order to create and institutionalize new organizational models and working arrangements.²⁵ Thus the point was made that science, technology and innovation policies will need to evolve through international coordination at levels of conceptualization, implementation and practice.²⁶ Recommendations on how to promote greater dialogue among scientists, engineers, practitioners, stakeholders, and policymakers were outlined in a number of briefs.²⁷ Recognition of the need for integrated assessment of crosscutting issues that relate to the achievement of several SDGs simultaneously was apparent throughout many briefs, defining a myriad of nexus approaches.²⁸

Sustainable urbanization, infrastructure, employment

Enhancing the science-policy interface is critical in addressing emerging issues in urban development and building resilient cities. Current methodologies to measure the state of urbanization across the globe and the degree of urbanization patterns may need to be updated so that policymakers and civil society can better address current and emerging urban challenges.^{29, 30}

Shifting to a green economy entails opportunities in many countries to develop renewable energy industries, where there is great potential for green jobs to create employment, if priority is given to education, training, and skills development for both technical and non-technical jobs.³¹ The space *underneath* cities also deserves more attention—research of sub-relief is important not only because of utility infrastructure, but also because of geological, geomorphological and ecological processes that can affect a city's resilience.³² Regional collaborative environmental governance is underway in some areas to balance economic development with ecological and social concerns, and ensure participation of civil society organizations, trade associations the media and communities.³³ Financial, political and societal efforts and innovations within the city structure will necessarily become increasingly synergistic and inclusive.³⁴

The unique challenges and structures of refugee camps can be effectively reimagined as spatial phenomena through which applications of urban social policy have the potential to provide relative autonomy for inhabitants, allow development of levels of self-organization that can generate eventual collaboration between refugees and government, and result in more sustainable outcomes for the displaced and vulnerable.³⁵

Public health, clean water and air

While stormwater reuse has great potential as a key adaptation measure to counteract the impacts of climate change on water resources available for urban use,

the increasing presence of dangerous water pollutants in stormwater runoff—including industrial chemicals, pharmaceuticals, and endocrine disruptors—is an emerging threat to public health and ecosystem services, especially in urban areas and places where water is scarce. New research on Emerging Water Treatment (EWT) processes has developed potentially sustainable alternatives for water treatment, including low-cost solar alternatives, but requires coordinated action by multiple actors to enable field level application and diffusion.³⁶ Wider availability of scientifically rigorous guidelines for stormwater reuse is also needed in most countries to protect public health and to guide good practice.³⁷

Urgent global action is needed to accelerate the prevention, control, elimination and eradication of neglected tropical diseases (NTDs) through sustainable drug development.³⁸ The outbreak of Ebola Virus Disease illustrates the interlocking nature of the socioeconomic determinants of health, especially within the context of sustainable development in poor and under-served communities in Africa. One brief highlights the need to better organize and finance global health emergency response systems, including an integrated global health emergency workforce, while also making health systems and infrastructure in the Africa region stronger and resilient.³⁹

New strategies and new ways of thinking are needed to maximize the ethical and sustainable impacts of big data for emerging issues in health policy, to ensure that no one is left behind.⁴⁰ Unified standards in disaster medicine can build capacity of future health workers to be more effective responders to humanitarian and disaster crises, contributing to increased resilience and sustainable development at the community level.⁴¹ Global health policy think tanks and academic institutions have a critical role in ensuring effective knowledge sharing, technical assistance to tackle implementation challenges, and the creation of innovative strategies to achieve better health in all regions of the world.⁴²

Countries in special situations

While this year's chapter focuses on issues of global relevance that can be addressed by the HLPF, different emerging issues may be most relevant at different geographical levels, from regional to national to sub-national. Some emerging issues at the national level may be common to groups of countries sharing certain characteristics. Such categories distinguished by intergovernmental processes and legislation at the UN include Least Developed Countries (LDCs), landlocked developing countries (LLDCs), and Small Island Developing States (SIDS). It is essential to pay attention to LDCs, as they have 12 per cent of the world's population, but 24 per cent of global poverty.⁴³ Many LLDCs are among the poorest of the developing countries.⁴⁴ SIDS have limited

Box 5-6: Selected emerging issues in LDCs, LLDCs and SIDS

Least developed countries (LDCs)

The fragile economies of LDCs in conjunction with trade and development challenges are further exacerbated by a high level of vulnerability towards internal and external shocks. There is robust evidence that climate change and climate variability worsen existing poverty, exacerbate inequalities, trigger new vulnerabilities and act as a threat multiplier for poor countries.⁴⁵ Another emerging issue for LDCs is the challenge of creating jobs and livelihoods for the young people currently entering the labour force - a number estimated to increase by 10.2 million people per year.⁴⁶ LDCs' share of global trade remains low at around 1 percent.⁴⁷

Landlocked developing countries (LLDCs)

Of the 31 land-locked developing countries, half are classified as LDCs. In addition to higher trade costs, landlocked countries on average export less than half of the per-capita amount of their maritime neighbours.⁴⁸ LLDCs are especially dependent on peace and stability in their neighbouring countries to maintain international trade. When transit countries are affected by civil war or other forms of social unrest, transit routes can be damaged or closed, which can result in the rerouting of major trade corridors and even an interruption in transit.⁴⁹ Overall, LLDCs showed little progress in human development with ten of the world's 20 lowest-ranking countries being landlocked, and the divergence between LLDCs and coastal developing countries is widening.⁵⁰

Small Island Developing States (SIDS)

Population displacements due to climate change are an emerging issue for SIDS as already widespread migration flows are exacerbated by adverse climate events. However, international laws to protect migrating populations across international borders due to environmental degradation or change are limited.^{51,52}

Another emerging issue is the impact of continued ocean acidification and associated coral bleaching. Acidified oceans could cause harvest failure of marine resources and thus could have a significant impact on fisheries in SIDS.⁵³ As coral reefs play a significant role in fish production and fisheries, marine biodiversity, coastal protection, and tourism, loss of coral reefs will have a major impact on SIDS economically, socially and environmentally.

Source: Authors' elaboration.

resources, remoteness, susceptibility to natural disasters, vulnerability to external shocks, excessive dependence on international trade, and fragile environments (Box 5-6).

5.3 Expert assessment of emerging issues

A common way to conduct exploratory scanning is through experts and expert networks.^{54, 55, 56} After a process of gathering issues, the initial list of issues or question is whittled down in the course of a combination of voting and discussions among experts. Such exercises have been conducted in various fields of study. For instance, in 2014 the international Antarctic community came together to 'scan the horizon' to identify the highest priority scientific questions for the next two decades and beyond.⁵⁷ Another recent consultative and priority-setting exercise sought to identify the 100 key research questions for the post-2015 development agenda, bringing together the research interests and priorities of academics and practitioners working on international development.⁵⁸

As an input to GSDR, an expert group meeting (EGM) was convened, bringing together the twenty specialists from different fields. During this face-to-face meeting, experts considered potential criteria for identifying emerging issues. They also considered a list of emerging issues for potential consideration by policymakers. To this end, the experts engaged in an indicative prioritization exercise, based on the indicative list of issues drawn from an electronic survey.

Prior to the meeting, an initial list of emerging issues had been collected using an open-ended online survey that was distributed to members of the sustainable development and scientific communities. As a next step, an electronic survey containing 85 issues was circulated to the participants in the expert group meeting, as well as larger group of experts, who were invited to score the issues on the basis of importance. Mean scores were calculated and a ranking list was generated (see Box 5-7).

The scanning exercise involved in support of the preparation of this chapter identified numerous candidate issues across a diversity of scales, disciplinary domains and substantive foci. During the discussion it was suggested the experts use the following criteria: regional relevance; policy relevance; urgency; evidence-based; probability and impact of event; persistence; irreversibility; latency/delayed response; ubiquity; novelty; potential for mobilization; and distribution of the issue across the world (See Table 5-6). The need to select and evaluate issues against transparent criteria was clear. So too was the need to explore connections among the issues, to synthesize issues where possible, and to identify common themes.

The experts discussed the 20 topics ranked highest from the online survey. The strength of the STEEP framework was recognized in enabling an initial categorization into different domains. However, expert input highlighted the usefulness of taking an additional step to differentiate between issues that relate to values, threats, opportunities, causal mechanisms and responses. Therefore, it was decided to look at a limited number of illustrative emerging issues through this prism. For each issue, the emerging threats concurrent with the issue's progression were considered. Thereafter, the experts discussed the opportunities and the corresponding causal mechanisms that would arise from addressing these emerging issues on a global political level.

Subsequently, potential actions and responses to mitigate emerging threats were examined. Finally, the key emerging features and characteristics of each issue were reviewed to summarize the primary considerations and alterations in political action. This approach is illustrated in Table 5-6 and in the text below, using four illustrative issues taken from the scanning exercise.

Establishing institutional mechanisms and partnership from global to regional, national, and local levels. It can be argued that institutions and institutional mechanisms for development provide the missing link that can explain the differences in growth rates and development trends across developing countries.⁵⁹ Partnership and trust between individuals and groups on all levels is a social asset with important economic benefits since it enables people to make agreements and undertake transactions that would otherwise not be possible.⁶⁰ The establishment of both institutional mechanisms and partnerships is of the utmost importance in securing global sustainable development and in order to “leave no one behind”.

Coping with the increasing impacts of climate change. Climate change is a defining human development challenge of this century. Changes in rainfall, temperature and water availability will have the most severe impacts on vulnerable countries. While climate change is hardly new a new issue, the experts agreed that climate change

Box 5-7: Priority emerging issues selected by experts in a indicative prioritization exercise

- Establishing governance mechanisms for the SDGs, from global (UN) to regional, national, and local levels.
- Coping with the increasing impacts of climate change.
- Political instability and social unrest from increased income and wealth inequalities.
- Ensuring access to affordable, sustainable, and reliable modern energy services for all.
- Accelerating the implementation of environmentally-friendly renewable energy.
- The need to develop alternative economic models that decouple economic growth resource use and minimize environmental degradation.
- The need to protect and restore ecosystems.
- Persistence of poverty globally, including the poor in rich countries.
- Strengthen and enhance the means of implementation and global partnership for sustainable development.
- Highly unequal distribution of household wealth across and within nations.
- Enhancing social protection and environmental protection in developing countries as a means to decrease inequalities and combat environmental degradation and climate change.
- Integrated assessment of sustainable development pathways.
- Increasing the sustainability, inclusiveness, safety, and resilience of cities and human settlements.
- Depletion of ocean fish stocks and exploitation of marine resources.
- Time lags of several decades between scientific findings and policy action.
- Migration and all forms of movement of people across borders due to changes in demographics, weather patterns, and other causes.
- Promotion of sustainable industrialization.
- Reduction of future agricultural yields due to climate change, especially in Africa.
- Inadequate funding for health systems, especially in developing countries.
- Putting in place the blend of governance forms and approaches required for the 2030 Agenda.

Table 5-6: Examples of emerging issues placed within a broader frame of structural issues

Emerging Issues	Values to be Sustained	Threats	Opportunities	Causal mechanisms	Responses/Actions	Key Emerging Features
	Societal value (Freedom, Equality, Solidarity, Tolerance, Respect for nature, etc.)	Threats to the value	Frequently technological opportunities to address threats or enhance the value	Causal mechanisms pertaining to threat or consequence, in particular poorly understood mechanisms, given these their 'emerging issue' status	Policy and institutional opportunities	Emergent characteristic
Coping with the increasing impacts of climate change	Solidarity, Respect for nature	Political inactivity, with political mechanisms failing to keep up with velocity of impacts due to climate change	Employment and growth opportunities associated with deployment of clean technologies. Inclusion of women in policy, and programming and implementation in the clean energy sector	Unrecorded/undiscovered CO ₂ emissions (sources) yet to be added to calculations Failure to restrict emissions according to levels determined by science	Interlinkages between action and impacts of different countries need to be made compelling	Accelerating impacts outpacing expectations and societal response rate
Addressing global poverty in rich and poor countries and the highly unequal distribution of household's wealth across and within nations	Equality, Dignity	Deepening structural inequalities; conflict	Broader dissemination of productivity-enhancing (smartphones) and life-saving technologies. Innovation in cognitive-behavioural interventions to enhance voice and agency		Enhanced access to basic services, social protection, Universal Health Care	Growth no longer guarantees reduced unemployment and poverty
Establishing institutional mechanisms and partnership from global to regional, national, and local levels	Freedom; Accountability	Break down of trust; institutional inertia and inaction		Existing institutional arrangements, characterized by vertical properties, do not function well for complex sustainable development problems	Institutional experimentation; decentralized responses with broader stakeholder involvement	Implementation & governance challenge posed by integrated nature of 2030 Agenda
Alternative economic models that decouple economic growth from resource use and minimize environmental degradation	Respect for nature, Equality	Vested interests; political economy	New technologies and business models; disruption and innovation	Development perceived as synonymous with GDP growth; path dependence and lock-in	Focus on consumption and production; pricing of environmental externalities	Possibility of sustainability transition

remains an emerging issue. First, this is due to both to time lags between scientific understanding and political action. Second, evidence points to an escalation of global impacts.⁶¹ Experts of the EGM considered that impacts were outpacing expectations, providing a challenge for political decision-making processes and societal responses.

Addressing global poverty in rich and poor countries and the highly unequal distribution of households' wealth across and within nations. While poverty rates have declined in most regions, progress has been unevenly distributed. While positive trends in East Asia led to 80 per cent reduction of extreme poverty in the past 20 years, poverty in sub-Saharan Africa still stands at over 40 per cent.⁶² Africa had the potential to benefit from the growth of its working age population, but this will require an expansion in productive employment. It was observed that economic growth does not necessarily have a direct effect on a country's poverty line or unemployment rate. The wage gap between the poor and rich is not only present in the developing world; developed countries are experiencing an erosion of their middle class, with a widening of the gap between poor and rich. The potential gains from the extension of social protection systems, including floors, were also highlighted as an area of interest.

Alternative economic approaches that decouple economic growth from resource use and minimize environmental degradation. Economic models today consider only economic growth without taking into account the positive and negative effects of resource consumption on human well-being. Negative effects include climate change, pollution, land-use change, and biodiversity loss. Economic development has so far been associated with a rapid rise in the use of natural resources such as energy, materials, water and land, but many of them are becoming less abundant relative to demand, and some run the risk of critical scarcity in the near future.⁶³ Resource decoupling is particularly important when a resource is scarce and further depletion could frustrate societal progress and when it poses high environmental risks that cannot be substantially alleviated through greater efficiency.^{64, 65} The greening of economies, enterprises and jobs can potentially contribute to poverty eradication, social inclusion and the fight against climate change.⁶⁶ Economic models need to be updated to address these issues.

The consideration of the issues revealed numerous connections among them, suggesting that higher order synthesis was appropriate. Issues expressed as threats, technological opportunities or management and policy responses often relate to single, broader underlying problems. For example, the broad trend of climate change can be associated with emerging threats, opportunities, and policy responses. Table 5.6, produced by the scientists consulted for this chapter of the report for illustration

purposes, shows how different threats, opportunities, causal mechanisms and responses identified during scanning relate to broader underlying issues. Annex 6, also produced by contributing scientists, provides a more detailed version of Table 5.6.

5.4 Conclusions

Following the initial consideration of emerging issues in the 2014 and 2015 Reports, this chapter aimed to provide a framework for: first, systematically identifying a range of issues for possible consideration by policymakers at the HLPF; and then, second, categorizing and presenting them. The chapter gives an overview of existing approaches to identification of emerging issues for sustainable development. It also demonstrates a possible approach to identify emerging issues, which could be used for future Global Sustainable Development Reports as well as for the HLPF.

Given the very broad scope of the SDGs, identifying emerging issues for sustainable development will require reviewing a broad range of sources. The chapter introduced "scanning" as a major approach for finding emerging issues. The chapter presents a sample of emerging issues from a long consultation process that involved a variety of sources, such as global UN initiatives and national and international academies of sciences. Several sources were used to provide a broad overview of the range of emerging issues that can be considered by policy makers. The process of scanning can be usefully guided by criteria, which help to make explicit assumptions about what counts towards designing issues as emerging. Impact and probability of occurrence are commonly used. Additionally, such criteria as persistence, irreversibility, ubiquity, novelty, and potential for mobilization have been considered. Priority, a criterion that is meant to capture an issue's importance in terms of social and cultural norms or impact on already vulnerable and marginalized groups, can accommodate principles such as "ensuring that no one is left behind".

The chapter also provides a simple framework for categorizing emerging issues, as well as criteria that the HLPF could consider using to filter emerging issues in order to identify a limited number of those that are most relevant. Indeed, intergovernmental processes can only consider a limited numbers of issues at a point in time, and not all emerging issues can be addressed by a specific process. For example, in the context of the HLPF, this entails identifying emerging issues that are appropriate for addressing at the global level, by filtering out issues of primarily local or national significance. Naturally there are no neat, clear divides; what is local today can escalate across borders tomorrow. In this chapter it is suggested that the following could serve as starting points: (a) the extent to which the

issue in question related closely to the SDGs; (b) whether the issue is a potential threat or opportunity of global or at least international relevance; (c) whether management of the risk or harnessing of the opportunity depends on international action and cooperation; and (d) whether the issue is expected to persist (non-transient) and whether or not a clear increasing trend can be established.

The chapter also reflects efforts made to test the approach proposed for the identification and filtering of emerging issues, which involved an expert assessment of emerging issues. Experts pointed to the interdependence among emerging issues. The expert assessment made clear that such interdependence is best perceived by replacing emerging issues in a broader framework, which clarifies the values that are to be sustained, potential threats and opportunities, causal mechanisms at play, possible responses and actions, and key emerging features.

At a broad level, the expert meeting categorized issues identified during the scanning exercise as the following. A first category was the operationalization of the 2030 Agenda for Sustainable Development and establishment of institutional and governance arrangements that explicitly recognize a role for science in policy and decision-making. A second category was key values to be protected or enhanced through sustainable development, including values which, while always implicit in the concept of sustainability, have gained greater recognition in recent years. A third category was critical processes of social, economic and environmental change that threaten sustainable development; in particular, processes that are novel, accelerating, approaching what appear to be

dangerous thresholds and/or which have poorly understood causes and consequences. A fourth category was emerging opportunities to promote sustainable development, including new technological options and policy responses to deal with both novel and unresolved sustainability issues.

The chapter demonstrates that a wide range of sources – document analysis, crowdsourcing, and expert meetings – can usefully be drawn on when identifying emerging issues in the context of sustainable development. The involvement of experts from multiple disciplines brings critical added value to this process, including for prioritizing emerging issues and provide multi-dimensional analyses of the issues and their inter-connectedness.

The exercise of emerging issues identification confirmed once again the complexity and inter-disciplinarity of sustainable development issues. Scientific expertise can shed new light on the complexity and interconnectivity of emerging issues, in the process strengthening the science-policy interface and possibly leading to more timely responses to emerging threats or the exploitation of new opportunities. The regular scanning and multidisciplinary analyses of emerging issues from different levels and perspectives is important and should be maintained as a necessary and useful early warning system for the science-policy interface.

There is scope for enhanced dialogue between scientists and policy-makers in considering both the processes by which emerging issues are brought to the attention of the HLPF, as well as the substantive character of issues that – out of the plethora of emerging issues – could usefully be considered by the forum.

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CONCLUSION

This concluding chapter highlights insights from the report that could contribute to strengthening the science-policy interface for sustainable development. The reader is referred to individual chapters and to the executive summary for a more comprehensive overview.

A message comes across strongly from chapters 1, 2, 3 and 4, even though their topics are very different and the scientific communities involved around each of them are distinct: if no one is to be left behind in 2030, the notion of inclusiveness cannot be treated as an afterthought or even mainstreamed in other areas. Rather, it should be an integral part of institution design and functioning, of research and development, and of infrastructure planning and development, to mention only topics covered in this report.

Improving our understanding of the effectiveness of development strategies in leaving no one behind

Ensuring that no one is left behind is a fundamental guiding principle for the implementation of the 2030 Agenda for Sustainable Development. Science can inform decision-making on three broad questions. First, who are those being or at risk of being left behind? Second, how can strategies and policies reach them in practice? And third, what types of strategies and policies would be appropriate in order to leave no one behind?

This report makes clear that many criteria are used in practice to identify those left behind, whether within a country or between countries. In practice, those “left behind” with respect to a particular dimension of the Agenda may be different groups in different societies. It is important to take into account the dynamic nature of deprivation and inequality; in this respect, preventive policies are critical to ensure that new people or group do not fall behind at the same time as others escape poverty and deprivation.

In many areas, inclusive development strategies are the commonly accepted paradigm. However, whether strategies succeed in reaching those left behind depend on many factors, from country-specific circumstances to their design, targeting methods and practical implementation. Available evaluations from different SDG areas all suggest that there are significant practical challenges in effectively reaching those left behind. Targeting, in and by itself, is not sufficient in order to leave no one behind –development interventions, even if properly targeted, can result in at best partial solutions to deprivations and, as a result, only address part of the problem.

Examples of interventions reviewed for the report that aim to reach the furthest behind first include: nutrition, where the core target of interventions in developing countries is those suffering the most from stunting; area-based interventions targeting the poorest locations; and strategies to provide shelter for homeless people.

Based on the limited evidence reviewed in the report, in many areas of the new Agenda, factoring in the imperative to leave no one behind in sustainable development interventions may not present insurmountable difficulties. Undertaking to systematically reach the furthest behind first may represent a much greater challenge and may in some cases imply a more significant departure from present strategies.

Going forward, it will be important to systematically collect further scientific evidence on how existing development strategies do indeed reach the furthest behind. A first step could be an inventory of existing meta-studies that attempt to review the effectiveness of development interventions in different SDG areas in reaching those left behind. While evaluations do exist for specific SDG areas, they use different criteria for defining and measuring those left behind or furthest behind and for assessing the effectiveness of interventions in reaching them. It could be worth assessing the costs and benefits of investing in more comparable frameworks for evaluating development interventions in different SDG areas. This would likely be a significant undertaking in terms of methodology and costs.

Adopting an integrated approach to sustainable development: the infrastructure-inequality-resilience nexus

This year's report examines interlinkages between infrastructure, inequality and resilience. Extensive bodies of literature have focused on each of these areas. For example, infrastructure has received significant attention in development circles, due to its perceived critical role in spurring economic growth and development. Yet, scientists focusing on each of those fields typically hail from different communities, making links between the three areas less commonly studied than any of the three areas taken in

isolation. Among the possible interlinkages in the nexus, an extensive amount of scientific research was found on the links between infrastructure and inequality, as well as on how people's resilience is affected separately by infrastructure resilience and by inequality. Links from resilience to inequality and from resilience to infrastructure seem to have received less attention. Further research in this area may be needed to uncover important synergies and trade-offs.

As in any nexus, harnessing synergies and addressing trade-offs is critical for policy-making. In this regard, the chapter illustrates the importance of adopting an integrated approach towards sustainable development. The research reviewed here emphasizes that a focus on both efficiency and equity is needed to harness the synergies between infrastructure, inequality and resilience. In this regard, contributing experts have noted that reducing inequalities in any of its dimensions also contributes to better infrastructure provision and increased resilience by, for example, increasing the likelihood of infrastructure investments that benefit vulnerable groups. An important policy component is geographic equity in the provision of basic infrastructure.

The report provides examples of policies that have been found to address synergies in the nexus. For example, labour-based programs in infrastructure projects can expand job opportunities and reduce inequalities, while at the same time improving resilience to natural disasters. Participatory processes that involve local communities and their various segments can be useful ways to ensure that considerations related to economic, social and environmental dimensions are taken into account when planning for infrastructure investment. Regulation and incentive mechanisms also need to be in place to integrate disaster risk reduction into all phases of the infrastructure life cycle, and to ensure the resilience of critical infrastructure to natural disasters. Contributing experts noted the need to further disaggregate the analysis between rural and urban contexts to be able to provide more specific policy recommendations.

Further cross-disciplinary collaboration and engagement between researchers, practitioners, decision makers and other stakeholders could be a way of achieving the mutual learning and transfer of information that would enable scientific knowledge to be transformed into practical strategies to harness the synergies and address the trade-offs between the three areas of the nexus.

Mobilizing technology for the SDGs: scientists' perspectives

The report presents a range of perspectives of scientists on the role of technology for the achievement of the SDGs. Technology is essential for achieving the SDGs and reaping the benefits of synergies among them, as well as for minimizing trade-offs among goals. Technology, society and

institutions co-evolve. Hence, technology progress requires institutional adaptations and may be constrained by social issues. Policy actions to achieve the SDGs and ensure that no one is left behind need to consider these interlinkages.

Many scientists point to a need for making simultaneous progress on equity issues (especially technology access), on overall technology system performance, and on supporting institutional change - strategies focusing only on one of these components have proven ineffective in the long-run. Innovation systems, understood as the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies, perform sub-optimally if only one or the other of these elements is supported. Policy actions must support both research and development to spur technology performance at the technology frontier, as well as promote the diffusion and adaptation of existing technologies in developing countries and among marginalized groups in all countries – one supports the other and vice versa.

Scientists emphasized a need for national and international technology roadmaps. Promising technological trajectories and new industries can be identified by each country. Scientists suggested the importance of investing at the same time in new and old technologies; in increased performance of advanced technologies and technology adaptations for underserved communities; in large-scale infrastructures and small-scale technologies with large numbers of units. They also suggested that science roadmaps should include measures relating to affordability and inclusion, which should be built into R&D processes from the outset.

Other notable key actions or policy elements suggested by scientists include: effective national science-policy interfaces; foresight and scenarios; facilitation of learning across communities, including underserved communities; and cluster analysis. The latter analyses networks of firms linked to each other (through production chains, or geographically concentrated and making use of related buyers, suppliers, infrastructure and workforce, or of similar nature), with a view to addressing systemic imperfections of innovation systems.

Inclusive institutions for sustainable development

There is clear awareness that the understanding of institutions is important for delivering on the imperative to leave no one behind. Institutions can trigger behaviours and trends that can have positive or negative impacts for development outcomes, and in particular for inclusiveness. Inclusive institutions bestow equal rights and entitlements and enable equal opportunities, voice and access to resources and services. On the other hand, power holders can shape institutions for the benefit of some rather than all groups of society.

Achieving any particular target related to inclusion (e.g. gender equality) will require a combination of factors, including: legal, regulatory components; multiple institutions intervening at various levels; and potentially broader societal changes, e.g. in social norms, which themselves can be spurred by changes in institutions. Conversely, individual institutions, especially those with broad mandates, can contribute to inclusiveness in many different areas as well as society-wide.

It is important to assess both how inclusive institutions are, and whether and how they foster inclusiveness through their actions. In this vein, the report explores two specific types of institutions: national councils for sustainable development (NCSDs) and national parliaments. More in-depth assessment of research is needed on other types of institutions and how they contribute to inclusiveness in the context of the new Agenda, and this should be a critical component of future GSDRs.

Research reviewed for the report suggests that, if provided with adequate resources, NCSDs can be effective mechanisms for stakeholder participation and engagement across the whole policy cycle, to: (1) inform and educate the public at large on sustainable development related topics; (2) stimulate informed public debates; (3) engage key stakeholders in formulating policy recommendations; and (4) involve stakeholders in various parts of implementation and progress reviews. In practice, governments' attitude regarding stakeholder involvement influences the functioning of NCSDs and the resources provided to them.

As legislative bodies, parliaments are very important for the implementation of the 2030 Agenda and SDGs. Their role in fostering inclusiveness can be examined at two different levels: first, how parliaments themselves are inclusive in their representation of all segments of society, including of marginalized groups; and second, how, when adopting legislation, they take into account the needs of these groups. The report focuses on the inclusion of four specific groups: women, indigenous peoples, persons with disabilities, and children and youth. Research reviewed for the report suggests that progress has been made with respect to the representation of these groups in national parliaments. However, gaps still exist. Similarly, while progress has been made in terms of codifying the rights of marginalized groups, there is still a long way to go in this respect, and parliaments will have a key role to play in ensuring that no one is left behind.

Identifying emerging issues for the HLPF

The identification of new and emerging issues warranting policy makers' attention is a critical function of the science-policy interface. Policymakers are exposed to a broad range of analyses, rankings, and advice concerning emerging issues. In addition, the sheer breadth of the sustainable

development agenda requires the consideration of issues from different sources and processes. Yet, intergovernmental processes such as the HLPF can only consider a limited numbers of issues, and by their mandate and place in overall governance frameworks can only address some issues.

There is scope for enhanced dialogue between scientists and policy-makers in considering both the processes by which emerging issues are identified, selected and brought to the attention of the HLPF, as well as the substantive character of issues that could usefully be considered by the forum.

The chapter demonstrates that a wide range of sources – document analysis, crowdsourcing, and expert meetings – can usefully be drawn on when identifying emerging issues in the context of sustainable development. The report introduces “scanning” as a major approach for finding emerging issues. The process of scanning can be usefully guided by criteria, which help to make explicit assumptions about what counts towards designing issues as emerging. Such criteria include impact and probability of occurrence, persistence, irreversibility, ubiquity, novelty, and potential for mobilization. Priority, a criterion that is meant to capture an issue's importance in terms of social and cultural norms or impact on already vulnerable and marginalized groups, can accommodate principles such as 'ensuring that no one is left behind'.

The report provides a simple framework for categorizing emerging issues, as well as criteria that the HLPF could consider using to filter emerging issues in order to identify a limited number of those that are most relevant. It is suggested that the following criteria could serve as starting points: (a) the extent to which the issue in question related closely to the SDGs; (b) whether the issue is a potential threat or opportunity of global or at least international relevance; (c) whether management of the risk or harnessing of the opportunity depends on international action and cooperation; and (d) whether the issue is expected to persist (non-transient) and whether or not a clear increasing trend can be established.

The report also reflects efforts made to test the approach proposed for the identification and filtering of emerging issues, which involved an expert assessment of emerging issues. Experts pointed to the interdependence among emerging issues. The expert assessment made clear that such interdependence is best perceived by replacing emerging issues in a broader framework, which clarifies the values that are to be sustained, potential threats and opportunities, causal mechanisms at play, possible responses and actions, and key emerging features.

The involvement of experts from multiple disciplines brings critical added value to this process, including for prioritizing

emerging issues and provide multi-dimensional analyses of the issues and their inter-connectedness. The regular scanning and multidisciplinary analyses of emerging issues from different levels and perspectives is important and should be maintained as a necessary and useful early warning system for the science-policy interface.

Taking stock from three editions of the Global Sustainable Development Report

Since UN Member States foresaw a Global Sustainable Development Report as an instrument to strengthen the science policy interface for sustainable development at Rio+20, three yearly editions of the report have been published by UNDESA in 2014, 2015 and 2016. Taken together, these reports have contributed to the science-policy interface in three main ways.

Firstly, since 2014, the Global Sustainable Development has become a platform and process for engaging scientists and experts in the UN deliberations on sustainable development. It has been open for participation to all interested UN entities, organized science institutions and programmes, and individual scientists – the only requirement being that contributions needed to be grounded in science. The process for the preparation of the reports sought to engage key players in organised science. In particular, the International Council for Science (ICSU) – the official organisation representing the scientific and technological community at the UN - has played a crucial role in encouraging scientific contributions. To date, 35 UN entities and more than one thousand scientists have contributed to the Report. The open call for science-policy briefs alone resulted in 589 scientists from all parts of the world submitting 264 briefs.

The approach followed for the three reports started from the premise that anybody interested in the GSDR should be able to provide inputs. For this reason, multiple channels for outreach and inputs were developed, from the most conventional such as relying on organized science to more innovative ones, such as open calls for science briefs in multiple languages. Through these channels, an effort was made to reach scientific communities (e.g., young scientists) that usually have limited access and input to large assessment processes. Multi-lingual crowdsourcing inputs and calls for papers have also sought to address the traditional bias of large assessment reports that rely on English language, peer reviewed science, leaving aside large bodies of literature in other languages that may be highly relevant to specific contexts, including regional experiences.

All editions of the GSDR benefited from advice and guidance from many senior scientists and experts of the science-policy interface, some of which had been involved in major efforts to devise sustainable development assessments in the past, including: reports from the US National

Academy of Science; the Global Environment Outlook; the Intergovernmental Platform on Biodiversity and Ecosystem Services; and others.

Secondly, the reports have provided specific suggestions on how the HLPF could operationalize the science-policy interface in practice in years to come. Chapter 1 of the 2015 edition suggested a range of ways for the HLPF to enable constructive interactions between science and policy-making at the UN. Actions that the HLPF might consider spanned the space between science and policy, from the provision of policy-relevant data, analysis and information, to actions that the HLPF could take to support enhanced dialogue between science and policy, to the translation of the results of science-policy dialogue into policy-making. Ultimately, it will be up to UN Member States to decide how they want the HLPF to strengthen the science-policy interface, and which of these actions they want to undertake, if any.

Among ideas considered by experts, providing improved access to the findings of existing assessments, highlighting synergies and trade-offs and tools to address them, and helping transpose the outcomes of global science-policy debates into regionally and nationally relevant frameworks for action were the most consensual. Many practitioners who provided inputs for this chapter emphasized the importance for the HLPF to consider a combination of

actions, rather than any single action, recognizing potential synergies among them.

All three editions devoted space to the identification of new and emerging issues, from their identification by all areas of science to how existing scanning processes may be combined to provide the HLPF with a usable list of topics for addressing in that forum.

Thirdly, the reports have explored different perspectives on the SDGs as an integrated and indivisible set of goals, and translated those in chapters that adopted a diversity of focuses and approaches. The chapters of the three editions of the report can all be clustered into a simple list of generic chapters, which are all relevant to an assessment of assessment approach covering the science-policy interface for sustainable development. This is illustrated in table 6.1. Such a structure emphasizes an integrated approach that focuses on the interrelationships among areas of the SDGs seen as an indivisible system, and a balanced consideration of the three dimensions of sustainable development.

For example, the 2014 edition provided templates for looking at progress made on sustainable development over the long term, as well as for synthesizing insights from sustainable development scenarios undertaken by leading institutions covering a wide range of thematic areas. The reports also included the examination of four clusters

Table 6-1: Generic chapters of past Global Sustainable Development Reports

Chapters	Generic description	GSDR 2014	GSDR 2015	GSDR 2016
Science-policy interface, including assessments	Describes the landscape of existing assessments; assesses the science-policy interface in various contexts	Ch.2	Ch. 1, Ch. 2	Ch. 1
Trends and review of progress	Reviews sustainable development trends in a comprehensive way for the whole set of SDGs seen as an indivisible system	Ch.3		
Sustainable development scenarios	Documents sustainable development scenarios and long-term modelling exercises published by diverse institutions in a uniform way	Ch.4		
New and emerging issues	Takes stock on existing processes to identify emerging issues and compares their outcomes. Provides science digests on issues of concern emerging in the scientific literature	Ch. 7	Ch. 7	Ch. 5
Featured clusters or nexuses	Takes an in-depth look at interlinkages, synergies and trade-offs among a subset of SDG areas, and examines the status of scientific knowledge on the various interlinkages	Ch. 6	Ch.3, Ch.5	Ch. 2
Cross-cutting issues	Takes an in-depth look at interlinkages between a cross-cutting issue (e.g. disaster risk reduction, institutions, technology, inclusiveness) and all the SDGs, and examines the status of scientific knowledge on the various interlinkages	Ch. 6	Ch. 2, Ch.4	Ch. 4, Ch. 3
Countries in special situation	Focus on overall progress, thematic or cross-cutting issues for one or several categories of countries in special situations (LDCs, LLLDCs, SIDS, Africa, and MICs)		Ch. 6	
Data and measurement (measuring progress)	Takes stock of initiatives aiming at measuring progress in different ways; highlights innovative data approaches on specific themes or in specific regions	Ch.5	Ch. 8	

Source: Authors' elaboration.

of issues (climate, land, energy and water; oceans and livelihoods; industrialization and sustainable consumption and production; and infrastructure, inequality and resilience), as well as cross-cutting issues (disaster risk reduction, innovative data and measurement approaches, technology). These contributions provide illustrations of how policy-relevant conclusions can be gleaned from existing scientific assessments.

As the Global Sustainable Development Report moves to a new phase after the HLPF 2016, the lessons learned in attempts to mobilize a broad range of scientific communities, and the collaborations initiated for this purpose, can provide an interesting base on which to build an ambitious yet actionable multi-year report for the benefit of the HLPF. Ultimately, the GSDR could become a science engagement platform for science-policy interface.

ANNEX 1

Annex 1: Examples of strategies used in various SDG areas and how they are geared to reaching those left behind.

Nutrition

Context:

Maternal undernutrition is estimated to contribute to 800,000 neonatal deaths and child undernutrition, consisting of stunting, wasting and micronutrient deficiencies, brings about 3.1 million child deaths annually.¹ By 2014, 159 million children under 5 were stunted, and. Progress in reducing stunting has been uneven. Low-income countries only accounted for 15 per cent of the global under-5 population in 2014, but nearly one quarter of all stunted children live in these countries. Less than half of all children under 5 lived in lower-middle-income countries in 2014, yet these countries accounted for two thirds of all stunted children globally.² Because stunting and its consequences are difficult to reverse after 24 months of age, interventions usually target pregnancy and young children.

Commonly used strategies:

Strategies to improve maternal and child nutrition tend to focus on adolescents girls and women, on infants and young children during the first 1000 days of life, on promoting optimal nutrition practices, meeting micronutrient requirements, prevention and treatment of severe acute malnutrition, and disease prevention and management.³ These strategies include promotion of breastfeeding, promotion of complementary feeding with or without of provision of food supplements, micronutrient interventions, general supportive strategies to family and community nutrition, and reduction of disease burden.⁴

Once pregnant and young children are targeted, effective nutrition interventions use a universal approach, focus on reaching food insecure groups, or focus on severe acute malnutrition (to reach the furthest behind). For example, from a comprehensive review of 43 nutrition-related interventions, out of 13 of those that were found to have evidence of effectiveness 11 could be implemented as universal within the target groups, one was universal in nature (e.g. universal salt ionization), and one targeted severe acute malnutrition.^{5, 6}

How 'reaching the furthest behind first' compares with other strategies:

Nutrition interventions that focus on the furthest behind, in terms of nutritional status or vulnerability, are particularly effective for reducing malnutrition. A meta-review of

studies that assessed the potential effect on child survival of scaling up nutrition-specific packages concluded that therapeutic feeding for severe acute malnutrition, which is a form of "reach the further behind first", would save from 620,000 to 917,000 lives, or as many lives as the other interventions combined. In addition, estimates of the effect of scaling up nutrition interventions show that the gains would be greatest in the poorest quintiles.⁷ A review of nutrition-sensitive programmes in the areas of agriculture, social safety nets, early child development, and education, show that they could be enhanced by, among other things, better targeting on the basis of nutritional vulnerability, in addition to targeting based on income or geographical location.⁸

It is important to note, however, that less targeted preventive interventions could be more effective than more targeted recuperative strategies. For example, a large programmatic intervention in Haiti found that given the difficulty to reverse stunting after 36 months of age a strategy of behaviour-change communication and food supplements for all children aged 6-23 months had a larger effect in reducing underweight and stunting than a targeted recuperative and food-support strategy that focused on underweight children under the age of five.⁹

How those left behind and 'furthest behind' are identified: Severe acute malnutrition (SAM) is detected by a weight-for-height Z score [WHZ] <-3, while moderate acute malnutrition (MAM) is characterized by WHZ <-2.¹⁰ In stable non-emergency situations with endemic malnutrition, MAM can often present in combination with stunting.¹¹

Health

Context:

Health is a good example of an area where the need to reach the furthest behind (not necessarily "first" though) has been on the forefront of national and international policy discussions. At the national level, the imperative to leave no one behind in this area is epitomized in discussions on universal health coverage, which have matured in many countries over the past two decades. It is also a constant concern in terms of design of health coverage systems, e.g. for the price of medicines and care that is paid by poor consumers. At the international level, efforts to combat "orphan diseases" especially in Africa have given rise to innovative policy approaches (e.g. advance market commitments). Efforts to reduce the price of medicines have also been ubiquitous and have given rise to action in international forums (WTO). In the case of HIV/AIDS, a range of responses by individual countries and the international community has included international action programmes, the creation of UNAIDS, action at the WTO, and others.

The challenge for leaving no one behind is that the availability of and access to relevant social and medical care is usually inversely related to the need of the population groups.¹² In other words, groups with the most pressing need for medical care tend to be those least likely to receive it. This is particularly central because people within the lower income groups not only tend to have more illnesses but also have more comorbidity.¹³ This can be compounded by the fact that many disadvantaged population groups, such as those in rural areas and poor populations, are also more likely to lack access to clean drinking water, sanitation and hygiene, which are essential for human health.¹⁴

Commonly used strategies:

A common strategy is universal health care, which attempts to guarantee comprehensive health coverage for the entire population. In Australia, for example, the socially disadvantaged are covered through publically funded healthcare via Medicare but actual access to medical care has been found to be limited due to excessive waiting time and scheduling difficulties. On the contrary, those who are privately insured receive care within a reasonable time frame through private appointments.¹⁵

Some programmes of universal care are focused on reaching the furthest behind first. Spain, for example, developed primary care health centres throughout the country but prioritized areas with the highest social deprivation first, which has yielded benign outcomes such as lower death rates.¹⁶ In Thailand, the people are insured through the Civil Servant Medical Benefit Scheme, the Social Security Scheme for individuals working in the private sector, and the so-called “30-Baht Scheme” for those who do not work for the private sector, non-working family members and children. The 30-Baht Scheme is a financially discounted program in order to insure the remainder of the population.¹⁷

Numerous strategies that target a specific population group focus on financially disadvantaged groups such as the unemployed and those working part-time, as well as socially disadvantaged groups such as women, children and seniors. According to the literature, the basis for much of health inequity is determined from early stages of life. Thus, prioritizing interventions at younger ages is a suggested approach.¹⁸

Some northern European countries and some provinces in Canada have attempted to regulate the distribution of health to achieve health equity by refusing to reimburse or pay physicians who settle in medically well-equipped areas. There have also been expansions of network of community health centres in deprived areas, and the benefits of this in the U.S. has been strong with lower low birth weight rates, better care quality and higher preventive service levels.¹⁹ Many developing countries have also made significant

progress towards achieving universal coverage. A study analysing 24 developing countries striving to achieve UHC, including Jamaica, Indonesia, Guatemala, Ghana and Nigeria, , shows that the countries are adopting two broad approaches: So-called “supply-side programs” channel investments to expand the capacity of service provision through increased funding for inputs (for example, human resources) and for reforms such as greater flexibility in staff recruitment, financial autonomy for public clinics, strong organizational protocols, and explicit performance indicators. “Demand-side programs” earmark resources to identified groups in the population and the services they use. They often do this by identifying and enrolling their target population and purchasing health care services on their behalf via output-based payments.²⁰

How ‘reaching the furthest behind first’ compares with other strategies:

The need for strategies that target the furthest behind first is highlighted in the health literature. Studies show that even when universal access to health services is an actively pursued goal, actual access can be skewed towards those better off. For example, in 21 OECD countries, most of which have explicit policy objectives to ensure equitable access to health care, people with higher incomes are significantly more likely to see a health specialist than people with lower incomes and, in most countries, also more frequently.²¹ Such pattern tends to make total doctor utilization somewhat pro-rich, which is further reinforced when private insurance or private care options are offered. While the issues of pricing are an important part of achieving UHC, geographical coverage and inhibiting distances to nearest health facilities as well as lack of quality of care are also barriers to reaching UHC.²²

It has been suggested that health inequality can be improved when considered in conjunction with macro-level factors and other economic and social policies.^{23, 24} Social class indicators and environmental stressors, such as poor housing conditions and high crime and unemployment rates, impact the relationship between individual-level risk factors and health.²⁵ For instance, while early initiation of prenatal care reduces the risk of low-birthweight infants, the protective effect of prenatal care is heavily dependent on the residential context. In high-risk neighbourhoods, the protective effect was low while low-risk neighbourhoods benefited from the care more substantially. Thus, basing policy solely on the individual-level analyses can overestimate the individual-level risks, leading to policy interventions with skewed consequences.²⁶

It is important to be cautious about the different uptake among the different social group in order to prevent widening inequalities. Experimental studies in the areas of accident prevention and use of educational booklets

for pregnant women had a greater impact on those in the higher social classes and exacerbated the inequality gap, emphasizing the eminence of targeted interventions in such cases.²⁷

Environment and Health

Context:

Insufficient attention is being given to ensuring a healthy environment as a means to improve human health and well-being. An estimated 23%²⁸ of total premature deaths were linked to environmental and modifiable factors in 2012 (12.6 million deaths globally), and the poor and other disadvantaged groups are disproportionately affected. Poor air quality and the consequences of inadequate water and sanitation services are among the primary environmental risks that affect health worldwide (see 1.1.7 on water and sanitation). Household air pollution prematurely kills 4.3 million people every year, nearly all in low- and middle income countries.²⁹ It particularly affects women and children, as they are more exposed to fumes from solid fuels used in cooking. Exposure to toxic chemicals due to inadequate workplace and housing conditions and proximity of homes, schools and workplaces to contaminated areas adds to the burden of disease, and its effects have become increasingly evident.³⁰ The effects of exposure to certain types of pollutants are exacerbated by poor nutrition and include, among other effects, influence neurocognitive development. Certain effects of exposure to toxic substances can be transmitted from mother to child, contributing to the intergenerational transmission of inequalities.³¹

Moreover, the world's poorest 3.5 billion people rely more directly on the environment for their basic needs, such as water, food and shelter, so ecosystem degradation affects them the most. Climate change impacts add to vulnerability by affecting the quantity and quality of water, soil degradation, disease patterns, and the frequency and intensity of droughts and extreme meteorological events.³² Again, the most affected are those with scarce access to adequate infrastructure, services and support systems. Over half a billion children currently live in extremely high flood occurrence zones, and nearly 160 million children live in areas of high, or extremely high, drought severity.³³

Commonly used strategies:

The health benefits of addressing environmental problems are not often quantified. As a result, investments and policies to that effect are underprovided. Moreover, for the most part, mainstream environmental policy does not specifically target the poorest or most disadvantaged groups. For some environmental problems, targeting specific groups is, in fact, unnecessary, as these groups will benefit from an efficient global strategy.

For example, as a result of the successful phase-out of nearly 100 ozone-depleting substances through the Montreal Protocol on Substances that Deplete the Ozone Layer (1987), up to 2 million cases of skin cancer and many millions of eye cataracts may be prevented each year by 2030. Moreover, by limiting the loss of stratospheric ozone, the Montreal Protocol helps to safeguard food security by reducing ultraviolet damage to crops and marine ecosystems. Cumulative estimates from 1987 to 2060 show that the global phase-out of chlorofluorocarbons (CFCs) alone will result in an estimated US\$1.8 trillion in global health benefits and almost US\$460 billion in avoided damages to agriculture, fisheries and materials.³⁴

For other environmental problems, however, the approach used can have different results for different groups of people. Where effects are localized or otherwise unequally distributed, environmental policy that does not specifically address the needs of the poorest may exacerbate inequalities. Groups (communities, individuals, countries) that are at a disadvantage in terms of their capacity to act collectively and influence policy design and implementation may benefit less from investments and may be left out in the allocation of scarce enforcement capacity. In some cases, in the absence of adequate policy, the very existence of socioeconomic inequalities may make it easier and cheaper for certain groups to transfer the environmental costs of their activities and lifestyles onto others rather than to internalize those costs.³⁵

How 'reaching the furthest behind first' compares with other strategies:

The choice of instruments for environmental management can have significant implications on who benefits from interventions in environmental matters. For example, in conducting inspections on plants that handle toxic substances, a "police-patrol" approach will conduct regular and uniform inspections, while a "fire-alarm" approach reacts to demands from affected parties. The latter will tend to be of greater benefit in communities with a greater capacity to articulate collectively and reach out to institutional channels, and may leave the most disadvantaged behind. A strategy that reaches the furthest behind first would include a police-patrol approach at least in the most disadvantaged areas.³⁶ Ensuring access to information, participation and justice in environmental matters are necessary components of a strategy to leave no one behind when addressing environmental issues. To reach the furthest behind first, policies need to address the special needs of vulnerable communities. Experiences to that effect include active outreach strategies to engage these communities in the identification and resolution of environmental problems affecting them through technical and financial support, legal assistance, and by providing environmental information in languages and formats

accessible to linguistic minorities;³⁷ legal empowerment of communities;³⁸ and inclusion of equity criteria in impact assessments and licensing criteria.³⁹

In some cases, strategies geared at reaching the furthest behind first are also efficient strategies to address environmental issues, with universal benefits. Replacement of traditional biomass cookstoves with modern fuel cookstoves, and of traditional cooking and heating with clean-burning biomass stoves would have considerable health benefits and would also represent 25% of the share of total avoided climate warming from Short-Lived Climate Pollutants reduction by 2050.

How those left behind and 'furthest behind' are identified:

The definition of those "left behind" varies depending on the type of intervention. Although the common methodology used looks at income distribution, interventions with regards to environment and health linkages tend to take into account the issue of vulnerability, to environmental degradation, targeting those which are most vulnerable to exposure to pollutants, other forms of poor environmental quality, climate change or natural disasters. Vulnerability to environment and health inequities are linked to many other social and economic factors, including the social and economic position of individuals, in relation to social class, age, gender and ethnicity, as well as education, occupation, livelihood and income levels. These factors determine where people live, what they eat, how and when in the life cycle they are exposed to pollution, and what options they have to change their conditions.

Some jurisdictions have adopted a pragmatic approach to enable targeting of particularly vulnerable or overburdened populations, and those that are likely to be unaware of the risks they face or to be unable to effectively take part in decision making. For example, in the State of Massachusetts, United States, the operational definition of "environmental justice populations" is "a neighborhood whose annual median household income is equal to or less than 65 percent of the state-wide median or whose population is made up 25 percent Minority, Foreign Born, or Lacking English Language Proficiency".⁴⁰ The state of California has adopted a screening tool - *California Communities Environmental Health Screening Tool* (CalEnviroScreen) - to identify vulnerable communities that suffer the largest pollution burdens, considering the location of pollution sources and demographic characteristics such as the concentration of children and elderly, low birth weights, asthma emergencies, education levels, linguistic isolation, poverty and unemployment. The tool is used in the allocation of resources obtained through the Greenhouse Gas Reduction Fund, a cap-and-trade programme.⁴¹

Conditional cash transfer programmes

Context:

The multi-dimensionality of poverty has long been recognized. Poor households are likely to suffer from multiple deprivations, including with respect to education, health, and employment, and be more vulnerable to shocks. Conditional cash transfer (CCT) programmes aim at addressing tackling multiple deprivations simultaneously in poor households. These programmes are usually designed with the philosophy that poor families are not able to invest enough in the human capital of their children, leading to poor nutrition, poor health and education outcomes, and use of child labour.

Commonly used strategies:

CCTs often combine components related to education, health and nutrition of the children, conditionalizing the given cash transfers with participation in schooling, natal care, vaccination schemes and so on, while aiming at alleviating current poverty simultaneously. For Brazil's Bolsa Familia for example, the transfer is conditional on pregnant women receiving timely prenatal and postnatal care visits, all children aged 0–5 within the household receiving timely vaccinations and growth-monitoring visits, and all children aged 6–15 attending school at least 85% of school days.⁴²

Some of the programmes aim at giving particular support to girls and women. In the case of Mexico's Oportunidades program for example, the grants given increase as children progress to higher grades at school and, beginning at the secondary level, are slightly higher for girls than for boys. The cash transfers themselves are given to the female head of the family.

Growing interest to CCTs, especially in poor countries was possible through an adaptation of more flexible approaches to encouraging human capital investment and blurring of lines between conditional and unconditional transfers, with some unconditional cash transfer programs (for example, in Kenya, Ghana, and Pakistan) introducing some co-responsibility arrangements with less stringent enforcement than in most CCTs (also called "soft conditionalities). CCTs in Africa are rarely a stand-alone activity. Instead, they usually come as a part of a package of safety net interventions that often also include a public works component. The three largest CCT financing activities in sub-Saharan Africa – Nigeria's Youth Employment and Social Support, Tanzania's Productive Social Safety Net, and Ghana's Social Opportunities Project – all combine a CCT with a public works component. Approaches that combine investments in human capital with CCTs and with the building of community infrastructure through public works have now been adopted by Egypt, Togo, Burkina Faso,

Cameroon, Republic of Congo, Niger, Madagascar, Chad and Mali.⁴³

By definition, CCT programs aim to reach those left behind in a socio-economic sense. The extent to which they have succeeded varies across countries. CCT are the most evaluated form of social safety nets. In recent years, there has been a large number of impact evaluations of CCT programs, and a dramatic shift from Latin America (where most of the initial impact evaluations were concentrated)⁴⁴ to lower-income countries in Africa (where one half of the evaluations conducted in the past 3 years were concentrated) and Asia.⁴⁵ Some of the most notable evaluations published over the last year include the impact evaluation of the Pantawid Pamilyang Pilipino Program in the Philippines.⁴⁶

CCTs, particularly those in Latin America, have been widely assessed, with mainly positive results. In Mexico, newborns in beneficiary families were 127.3 grams heavier and 44.5 percent less likely to be low birth weight than newborns in non-beneficiary families.⁴⁷ Bolsa Familia has increased girls' school participation by 8.2 percentage points.⁴⁸ The probability that a child received all seven vaccines required by age 6 months increased by 12–15 percentage points and increased pregnant mothers' use of prenatal care by 1.5 prenatal care visits on average.⁴⁹ A 2012 evaluation of Brazil's Bolsa Família program yielded evidence of how beneficiary women made decisions that resulted in better living conditions for both children and women.⁵⁰ Bolsa Familia has even been linked to reduced crime rates.⁵¹ The findings of evaluations of Nicaragua's Atención a Crisis underscored the long-term positive potential of health interventions focusing on early childhood intervention. It was found that households who received Atención a Crisis transfers had increased their expenditure on critical inputs into child development (such as more nutrient-rich foods, more early stimulation provided to children, and more use of preventative health care). This had led to improvements in the cognitive outcomes of children aged 36 months old from beneficiary households, and even two years after the program was ended and the transfers had been discontinued, these positive effects continued.⁵²

The success of Latin American CCTs has encouraged developing countries around the world to adopt similar schemes. However, the success of these schemes requires that good quality services are available and physically accessible for the participants and that the public sector has the capacity to run fairly complex transfer schemes.⁵³ In some cases, these requirements have meant in practice, that those furthest behind, for example in rural areas, are left outside of the programme reach. For instance, in Nicaragua, the programme was initially implemented in departments that satisfied minimum administrative and infrastructure requirements.⁵⁴ Colombia's Familias en

Accion (FA) has included poor municipalities with fewer than 100,000 inhabitants, a bank and adequate education and health infrastructure.⁵⁵

Several countries have strengthened linkages between cash transfers and early childhood development (ECD). Conditional cash transfer programs can serve as effective vehicles for promoting early childhood nutrition, health, and development, in addition to their more traditional role of providing income support to the poor and vulnerable. Where ECD services exist, cash transfer programs can help households overcome barriers to access, for instance by making the transfers conditional on health visits, growth monitoring sessions, or attendance in preschool. Cash transfer programs can also help encourage changes in parenting practices to promote early childhood nutrition, psychosocial stimulation, or health. Countries having tested similar approaches include Burkina Faso, Djibouti, Mali, and Niger.⁵⁶

Accompanying measures to promote ECD are also being implemented in middle-income countries. In Indonesia, the conditional cash transfer Program (CCT) program Keluarga Harapan (PKH) covers 3 million poor families nationwide. The program not only provides cash, but also provides beneficiary mothers with skills. Training modules seek to promote sustainable behavioral changes in relation to early childhood education and parenting practices, and extending to such topics such as family finances or microenterprises. The training modules are given during monthly meetings that CCT beneficiaries have at local level, over three years. Messages are harmonized through the use of videos that represent daily situations of a typical CCT family.

How 'reaching the furthest behind first' compares with other strategies:

Some CCT schemes contain an element that aims at targeting the support to the furthest behind in addition to supporting poor families. For example, transfers associated with Bolsa Família consist of a conditional payment per child aged 0–15 years, for up to three children, to "poor" households below a per capita income threshold, but in addition, an additional unconditional transfer is given to "extremely poor" households below a lower per capita income threshold.

Some programmes also aim at providing additional incentives for tackling issues such as school dropouts. In Brazil in 2008, a complementary Benefício Variável Jovem program was introduced, which added variable payments and a schooling conditionality for children aged 16 and 17, requiring attendance at least 80% of school days.

Other programmes are including support to recover from disasters tackling families that are especially vulnerable to hazards, in an effort to minimize the negative effects that these events have in poverty eradication. This is the case,

for example, of Chile (*Chile Solidario*), Ecuador (*Bono de Desarrollo Humano*) and Mexico (*Prospera*, successor of *Oportunidades*).⁵⁷

In Panama, the Red de Oportunidades Led is targeted to the poorest and the indigenous communities. According to one assessment, the programme implementation led to a reduction in child labour among 12–15-year-old children by 15.8 percentage points and to increased elementary school enrolment by 7.9 percentage points in indigenous comarcas.⁵⁸

How those left behind and 'furthest behind' are identified:

CCTs can cover large sections of societies (approximately 26 % in Brazil) or narrower groups (3% in Nicaragua). Good targeting and identification of the group is crucial for the effectiveness of the programme.

Most Latin American CCTs rely on proxy-means tests for identification of the poor. A notable exception is Brazil's Bolsa Familia, which relies on self-declared per capita household income.⁵⁹ CCTs may also rely on geographic targeting to target priority areas, whether based on welfare levels or on other requirements such as minimum infrastructure facilities, or a combination of both.⁶⁰ Some programmes also use community means testing as the way to identify the ones eligible.⁶¹

Payments for ecosystem services

Context:

Payments for ecosystem services (PES) programs were originally designed primarily to meet conservation goals rather than poverty reduction objectives. Conservation strategies can indeed present constraints and challenges especially for the communities and local residents leaving in and around sites identified and designated for the implementation of such environmental conservation programmes. The challenges and constraints include lack of or reduced access by communities to services provided by the ecosystems. These challenges are exacerbated when they directly affect the poor and landless as they are for all intent and purpose effectively locked out of their sources of survival and livelihood. The understanding and practices of implementation of incentive programs such as PES have evolved and the need to balance conservation objectives and socio-economic imperatives are now widely recognized. Involving local residents or users of natural resources in conservation efforts and providing incentives to local communities to support and participate in conservation efforts is now standard practice. In the past three decades, a rapidly growing number of ecosystem functions have been characterized as services, valued in monetary terms and, to a lesser extent, incorporated into payments for ecosystem services (PES) schemes.⁶² Such

schemes have thus become one of the common tools used to manage environmental issues.

Commonly used strategies:

Under a typical payment for ecosystem or environmental services (PES) scheme, the party supplying the environmental services agrees to manage the corresponding resource or the service that provides a flow of benefits to another party according to certain requirements, in return for compensation. Some PES programs are purely private arrangements. However, the majority of the PES programs are funded by governments and involve intermediaries, such as non-government organisations. The majority of existing schemes operate in the areas of climate change mitigation, watershed services and biodiversity conservation.⁶³

The primary focus of PES is on maintaining or restoring ecosystem services, not on poverty alleviation. However, during the past decade there was increasing interest in whether PES could, in addition to environmental objectives, also capture and accommodate poverty reduction objectives, especially in developing countries. A multi-country study based on observations from three tropical continents found that poor (environmental) service providers could broadly gain access to PES schemes, and generally become better off from that participation, in both income and non-income terms.⁶⁴ However, the study pointed out the need to also look at the impact of PES schemes on service users nonparticipants. Several studies including a 2005 study conducted by the World Resources Institute on the Challenges of Pro-Poor PES found that: lack of security of tenure; restriction on land uses; high transaction costs; lack of credit and start-up funds represented serious challenges for the poor who were denied access to benefits.

The various participation filters of PES schemes contain both pro-poor and anti-poor selection biases, and different mechanisms have yielded different results in terms of reaching the poorest. Quantitative welfare effects are by nature small-scale compared to national poverty-alleviation goals.⁶⁵ The study concluded that while some pro-poor interventions are possible through PES, the prime focus of such schemes should remain on the environment.

How 'reaching the furthest behind first' compares with other strategies:

As described above, payments for ecosystem services are not explicitly designed to achieve poverty eradication objectives. The precise design of the payments systems influences the distribution of the payments across participating and non-participating groups; hence, PES can be more or less focused on those furthest behind, depending on the case. Carefully designed PES schemes can become more focused on those left behind ("the poorest") and those unable to cross above the poverty line.⁶⁶

How those left behind and 'furthest behind' are identified:

In evaluations of the pro-poor nature of PES, income and derived poverty indicators are commonly used as a measure for those "left behind". However, the evaluation of the pro-poor nature of PES programs needs to include other poverty indicators as well, such as health, education and other social indicators as gauges for those "left behind".

Access to shelter*Context:*

For shelter policy in developing countries, perhaps the most notable trend in recent decades is with respect to the spatial dimension of poverty. Though the majority of the world's poor continue to live in rural areas, poverty has rapidly become an urban phenomenon. Today, unlike the situation thirty years ago, in many countries – e.g. Russia, Brazil, Mexico – most of the poor reside in urban areas. In other countries, the poverty rate in urban areas is higher than it is in rural areas.

A clear failure of urban interventions in past decades is shown by the inability to eliminate slums. Although the MDG slum target was reached, the number of slum dwellers, in absolute terms, continues to grow, with an estimated 863 million people living in slum conditions in 2012.⁶⁷ This is not only a result of massive migration flows into the cities of the developing world. Surveys in Brazil and India, for example, indicate that in many places slum dwellers are no longer immigrants who recently arrived from rural areas in search of better livelihoods. Today, many of the 100,000 pavement dwellers in Mumbai, for instance, are second generation residents,⁶⁸ as is the case in Rio's Favelas.⁶⁹

The broad environment has significantly changed over the last three decades. Urbanization is no longer thought of only as an engine of growth that occurs as societies grow and specialize. A more robust understanding of how housing and land markets work has emerged in both developed and developing countries. There is now much more available information and an active body of research on real estate economics in general and for developing countries in particular. Many countries have evolved sophisticated financial systems. For instance, many developing countries now have access to market rate housing finance to assist them. This has come with associated crises in some cases.

Commonly used strategies:

Strategies to provide access to shelter in an urban context have a history of several decades if not centuries. In developing countries, urban projects initially undertaken by international financial institutions were usually designed to help develop sites and services in low-income countries.

Most of the initial projects were in capital cities and attempted to show that basic housing services, e.g. shelter, water and sanitation, could be provided at much lower cost than the housing then being provided by the public sector. At that time there was considerable resistance this idea. Most developing country public housing agencies produced expensive and heavily subsidized housing that could only meet the needs of a fraction of the demand. These projects also provided an alternative to demolishing squatter settlements as was done in many countries. The overarching idea of the assistance was to suggest that rather than attempting to replace the informal sector, or see this sector as a "problem", public assistance could be used so that the strengths of this sector could be built upon. Providing just basic services and shelter allowed poor families to expand their units over time as their savings and resources permitted. It also allowed them to use their own labor to maintain and increase their wealth. A change came in the early 1970s with a shift to upgrading of existing slums rather than just the development of new sites.

The second change was to move from shelter-centered projects to broader interventions that included issues such as municipal finance, urban management and inter-governmental relations. Later, other types of interventions were centered on housing finance and broader housing policy environment, as well as disaster relief. Lastly, in the late 1990s, housing micro-finance started to be seen as a way to provide access to housing finance further down the income distribution. Various interventions in housing markets continue to target the low-income rental sector (both public and private).

How 'reaching the furthest behind first' compares with other strategies:

The degree to which urban policy interventions and strategies reach those left behind depend on the specific nature of the interventions and the local context. Yet, some general lessons can be drawn^{70, 71} In general, subsidy instruments have not been a panacea to reach the poorest.

In as much as slums provide shelter to those furthest behind in the urban context, interventions directed at slums reach this category. Their impact, however, depends on the design and implementation of urban interventions.

How those left behind and 'furthest behind' are identified:

The definition of those "left behind" varies depending on the type of intervention. For example, interventions aiming at expanding mortgage markets for individual ownership will focus on those at the margin of formal housing finance, who are typically not at the bottom end of income distribution. Intervention in slums is area-based; in addition, additional criteria within specific interventions may try to further target people or households who are most vulnerable or poor.

Access to drinking water and sanitation

Context:

Improving access to safe drinking water and sanitation has long been recognized as one of the main challenges of sustainable development, with improper water management having a direct impact on human and ecosystem health, food and energy security among many other areas which support human well-being and livelihoods. 147 countries achieved the MDG target relating to access to drinking water, while 95 met the target for sanitation. Over 90 per cent of the world's population now use improved sources of drinking water, and 68 per cent use improved sanitation facilities.⁷² The value to households of access to improved water and sanitation facilities includes direct net savings or expenses from buying water from alternative providers and savings in health expenditure to treat water-borne disease and indirect benefits in terms of time freed up to get water closer or into the household, improved nutrition, increased school attendance especially for adolescent girls and the safety and dignity of improved sanitation compared to open defecation of shared facilities. In most developing countries without universal access, use of improved facilities is higher in urban areas than in rural areas.⁷³ Households not having access to individual piped water connections must rely on alternative sources for water, whose price is often much higher than that of water provided by utility companies. Households in dense urban areas often have few options for improved sanitation and removal of excreta from communities due to a lack of space and service providers.

Investment in water and sanitation has also long been recognized as having a very high social rate of return. For example, in 2004 WHO and UNICEF estimated that the return on investment in water and sanitation services in developing countries ranged between US\$5 and US\$28 per dollar.⁷⁴ Improved access to safe water and sanitation has many co-benefits in other areas. For example, it has resulted in the number of diarrhoeal diseases attributable to inadequate water, sanitation and hygiene to fall from 1.8 million to 842,000 between 1990 and 2012, with all regions experiencing major declines.⁷⁵

Commonly used strategies:

Strategies used all over the world ultimately aim to provide universal access to safe drinking water and basic sanitation. In that sense, they are directly geared to leaving no one behind. In many countries, strategies for universal drinking water coverage are designed within the paradigm of individual water connections provided by a utility company through a network. The precise institutional features of utilities and their degree of autonomy from the government vary widely across countries. However, the challenge facing governments is the same, i.e. to ensure reliable access to

safe water at affordable rates, without compromising the long-term financial sustainability of the water provision system. Strategies for universal coverage of sanitation tend to rely on a mix of extending formal services (sewerage networks and septic tank systems) while encouraging private investment in sanitation improvements.

In countries with a large share of the population without access (e.g. large rural populations), the network structure of water and wastewater service provision provides an incentive for planners to reach "low hanging fruits" first by extending connections in proximity of existing networks or water production plants, thus not necessarily reaching those furthest behind first. Globally, eight out of ten people without improved water, and seven out of ten without improved sanitation, live in rural areas where networked solutions may not be achievable or affordable in the short to medium term, and low cost solutions operated and managed by the communities are still the main option. In countries where the majority of the population has physical access to improved facilities, strategies to facilitate affordability of water become the main channel to reach those furthest behind.⁷⁶

Water tariffs and associated subsidies have traditionally constituted the preferred instrument by which governments have tried to resolve this issue. The majority of water subsidies to households are delivered to customers connected to the network through low tariffs. A frequent way of subsidizing water consumption is through increasing block tariffs where the first consumption blocks are subsidized, while the highest blocks are priced above cost. The costs of wastewater collection and treatment are frequently cross-subsidized by revenue from water tariffs. The construction and maintenance of on-site sanitation systems presents substantial economic burdens to low-income households, but the large number of poor households without sanitation makes it difficult for governments with limited budgets to provide effective subsidies.⁷⁷

Review of the experience accumulated in various countries has provided a number of robust lessons regarding water subsidies. Consumption subsidies delivered only through low tariffs are typically not well targeted to the poorest households. Access factors biased against the poor make subsidies through low water tariffs unlikely to reach the poor. The proportion of households having potential access to the network is often higher for non-poor households than for poor households. In practice, subsidized tariffs have often resulted in regressive redistribution schemes.⁷⁸

In past decades, new practices in the design and delivery of subsidies have emerged. An increasingly common form of water provision consists of a menu of services, differentiated by quality, associated with different tariffs. Typically, subsidies are associated with the lower quality

service. The objective is to target subsidies to the poorer households or neighbourhoods, by allowing households to self-select the form of service they prefer to use, the implicit assumption being that poor households are more likely to use the (subsidized) lower-quality service. Another objective is to achieve a greater coverage with the same amount of investment, lower quality services such as community taps being less costly to provide and covering the needs of more households than private connections.

Direct consumption subsidies are paid directly to households meeting certain eligibility criteria (low income being the most obvious criterion) to cover part of their water bill. The direct subsidy system was pioneered by the Chilean government in 1990, when it was successfully used to soften the distributional impacts of a convergence towards cost-reflective water tariffs. The main advantages of direct subsidies are that they are transparent, explicit, and minimize distortions in the behavior of water utilities and their customers. The main drawbacks are the difficulty of defining suitable eligibility criteria, as well as the administrative cost entailed in identifying eligible households.

Connection subsidies have become more and more frequent, based on the recognition that, for some groups of the population, the main obstacle to connection to the network is not that of paying the monthly water bill but rather paying the initial connection fee. Connection subsidies also provide a strong incentive for water providers to extend the network.⁷⁹

One emerging approach is to provide hardware subsidies on an output basis rather than an input basis. Providing a subsidy on an output basis can ensure that the activity that is subsidized is actually delivered, and can be effective at stimulating demand and leveraging private investment. It can also give incentives to producers to reduce costs and to serve areas which they might otherwise not consider.⁸⁰

How 'reaching the furthest behind first' compares with other strategies:

In general, it is easier to extend a network for water provision from existing networks or from water production centers. To the extent that those furthest behind live farthest from areas already served, strategies to extend water provisions may not spontaneously reach the furthest behind first. Doing so requires a deliberate prioritization of the most underserved areas and groups.

How those left behind and 'furthest behind' are identified:

The most commonly used indicators at the country level are the percentage of households having access to a safe source of drinking water and basic sanitation facilities. However, several scales and categorizations are used, and different

monitoring processes use different definitions of access to water and sanitation.⁸¹ Administrative targeting in various forms is increasingly used to administer programmes that aim to improve affordability of water for the poor. Methods used going from categorical targeting, to selection based on family structure and location, with the most sophisticated methods relying on means testing.⁸² Selection based on family size alone is usually found to perform poorly in targeting the poorest households. The power of geographic targeting depends in large measure on the correlation between poverty and location of households. Geographic targeting has given interesting results in Nepal, but seems to have limited potential in Colombia and Senegal.⁸³ Sanitation subsidies have been delivered using a range of methods, including geographic targeting, means-tested targeting, community-based targeting, and self-selection targeting, with the latter two approaches appearing to be more effective than means-tested systems, which can be costly and generate perverse incentives.⁸⁴

Persons with disabilities

Context:

Persons with disabilities are overrepresented in the furthest behind when looking at almost any of the SDGs. Households with a person with disability are more likely to experience material hardship – including food insecurity, poor housing,⁸⁵ lack of access to safe water and sanitation, and inadequate access to health care.^{86, 87} Children with disabilities are less likely to get an education, less likely to be employed as adults, less likely to start their own families, and more likely to live in poverty.⁸⁸ People with disabilities are more likely to be unemployed and generally earn less even when employed around the world.⁸⁹ On average across the OECD, the income of persons with disability is some 15% lower than the national average and as much as 20-30% in some countries.⁹⁰ Persons with disabilities also have limited opportunities to seek and receive information and knowledge, particularly public, available in accessible, affordable and adaptable formats and tools.⁹¹ This limits their opportunities to make the transition from education to work and ensure full participation in society. They are more likely to die in disasters, to be left behind during evacuation, or may have limited access to emergency shelters and transportation systems^{92, 93} and disaster risk reduction programmes that target people with disabilities remain the exception.⁹⁴

Commonly used strategies:

The needs of persons with disabilities are often addressed through a twin track approach, through specific programs targeting persons with disabilities as well as through provisions added to mainstream community-wide policy interventions.

For example, to address exclusion from employment markets, countries use a variety of mechanisms, such as anti-discriminatory laws and regulations, quotas for persons with disabilities at the workplace and incentives (tax credits, support to the employers for accommodation or workplace modifications), special supported employment, training programmes, and microfinance for self-employment.

Access barriers to health care for persons with disabilities are often complex,⁹⁵ ranging from barriers related to the affordability, to physical accessibility, to communication with health care professionals and so on. In some cases, primary health care can be the best solution for providing health care for persons with disabilities, along with support from specialized services.⁹⁶ This has been proven efficient for example with persons with mental health problems, minimizing stigma and discrimination.⁹⁷ However, targeted interventions can be used to reach those that are not otherwise included in broad-based programmes. Examples of such interventions include outreach teams in Brazil and India follow-up on patients with spinal cord injuries to address issues such as skin care, bowel and bladder management, joint and muscle problems, and pain management,⁹⁸ or ensuring that educational materials on HIV/AIDS for youth are made in accessible formats such as videos with sign language.⁹⁹ In some cases practical arrangements can make a difference for accessibility, such as building ramps to access hospitals and health care centers, or procuring mammography equipment that can accommodate women who cannot stand.¹⁰⁰ A significant shift in the design of mainstreaming ICTs to incorporate accessibility and user functionalities for the widest number of users has been introduced by various producers which provide new opportunities for persons with disabilities to access to information and knowledge.

Strategies aiming towards inclusion of persons with disabilities are by design aiming to reach those left behind. However, in some cases the evidence of real impacts and costs and benefits of these strategies, for example for enhanced employment opportunities, are still lacking and further research is needed.¹⁰¹

How 'reaching the furthest behind first' compares with other strategies:

Some strategies aim to reach those furthest behind. For example, efforts have been made in a number of countries to support inclusive access to justice for children with disabilities. In Zimbabwe, targeted services have been provided to children with disabilities in regional courts, and police seek professional services as soon as a child with disability is identified as a survivor, witness or alleged offender. Stand-by teams of disability experts have been established in regional courts. This has improved communication and interpretation of evidence by court

intermediaries in cases of abuse and rights violations, resulting in effective and consistent prosecution and expeditious adjudication of pending cases by magistrates and public prosecutors.¹⁰² In relation to inclusive social protection schemes, Jamaica, for instance, has combined its conditional cash transfer programme to poor families with children up to 17 years of age with unconditional cash transfers for families caring for children with disabilities, along with free home-based health care visits.¹⁰³ In some countries, access to information and knowledge for students with disabilities, particularly through Open and Distance Learning, is ensured by applying procurement procedures and practices that include accessibility standards and requirements for persons with disabilities from the outset.

How those left behind and 'furthest behind' are identified:

Disability, a complex multidimensional experience, poses several challenges for measurement. Approaches to measuring disability vary across countries and influence the results of research and reviews.¹⁰⁴ Historically, reported prevalence estimates have varied widely because of different definitions of disability and the fact that data has often been of poor quality. However, efforts have been made to address this situation in recent years, and estimates of the prevalence rates of adults with disabilities are becoming more reliable and less varied in quality. The International Classification of Functioning, Disability and Health, known more commonly as ICF, is the WHO framework for measuring health and disability at both individual and population levels.¹⁰⁵ As the functioning and disability of an individual occurs in a context, ICF also includes a list of environmental factors. Determining disability in childhood through survey data is complicated because of the natural variance in children's development, the differing cultural standards of what children are expected to be capable of doing, and the need to use proxy respondents.¹⁰⁶ Recently, UNICEF and the UN Statistical Commission's Washington Group on Disability Statistics have developed a survey module for identifying children with disabilities in surveys.

In terms of reaching the furthest behind, some programmes pay particular attention to persons with multi-layered vulnerabilities, such as children with disabilities.

Access to primary education

Context:

The world has achieved considerable advances in primary education during the life span of the MDGs. For example, the primary school net enrolment rate in the developing regions has reached 91 per cent in 2015, up from 83 per cent in 2000.¹⁰⁷ However, poverty, children's gender, caste, ethnic and linguistic background, race, disability, geographical location and child labour continue to serve as barriers for many children's education.¹⁰⁸

Almost 16 million girls between the ages of about 6 and 11 will never get the chance to learn to read or write in primary school compared to about 8 million boys if current trends continue.¹⁰⁹ In South and West Asia about 4 million girls will never get the chance to learn to read and write in primary school, compared to almost 1 million boys.¹¹⁰ However, future challenges in developed countries seem very different. A recent OECD study shows that girls outperform boys in reading in almost all of the PISA study countries. This gender gap is particularly large in some high-performing countries, where almost all underperformance in reading is seen only among boys, demanding special strategies to address this gap.¹¹¹

Despite improvements in recent decades, children and youth with disabilities are less likely to start school or attend school than other children. They also have lower transition rates to higher levels of education.¹¹² Research shows that disability is a stronger predictor of educational enrolment than either gender or socio-economic class in a study of 11 developing countries.¹¹³

Children in conflict-affected countries account for just 17% of primary school-age children, but more than one-third (36%) of all children who were denied an education in 2012 globally. This failure means that children of primary school age in fragile and conflict-affected situations are nearly twice as likely to be out of school than children in the developing world as a whole.¹¹⁴

Commonly used strategies:

In many countries, education is seen as a primary policy lever to reach those left behind and as a key means of enhancing and democratizing learning opportunities for children coming from disadvantaged families or communities. Although the ways education systems are financed varies widely across countries, a number of countries provide primary and secondary education for free, with some investing extra resources in school districts located in disadvantaged neighborhoods.^{115, 116}

Key factors contributing to enhancements in universal primary education have included abolishing school fees; increasing demand for education through initiatives such as cash transfers, school feeding programmes and take-home rations; increasing the supply of schools and classrooms, investing in teachers' quality and incentives, as well as investing in health and infrastructure.¹¹⁷

Evidence-based policies and strategies to address exclusion in education include elimination of cost barriers through, for example, cash transfer programmes; provision of school meals/nutrition and health services; provision of learning and teaching materials and transport services; second chance/re-entry programmes; inclusive school facilities; teacher training on inclusive education; and language policies to address exclusion.¹¹⁸

To ensure gender equality in education systems, Governments and partners have mainstreamed gender issues in teacher education and curricula and monitoring processes, and have aimed to eliminate gender-based discrimination and violence in education institutions to ensure that teaching and learning processes have an equal impact on girls and boys, women and men, and to eliminate gender stereotypes and advance gender equality. Evidence has found the importance of putting in place special measures to ensure the personal security of girls and women in education institutions and on the journey to and from school, in all situations but in particular during conflict and crises.¹¹⁹

How 'reaching the furthest behind first' compares with other strategies:

Education strategies and policies have encompassed measures aiming to reach groups at a special disadvantage. Focusing on children with disabilities, subject to the context, availability of resources and engagement towards fostering more inclusive societies, countries are adopting different strategies to progress towards inclusive education that addresses the needs of all learners in regular schools. In some countries, segregated educational provision for children with disabilities is still prevalent.^{120, 121} Others have opted for models more geared towards inclusion, which involve the reduction of special school provision by employing whole-school policies and planning to develop inclusive approaches that respond to a wide range of learning needs and diversity of learners. Other models are based on the premise of the development of inclusive regular schooling and inclusive pedagogy, while keeping some separate specialized provision particularly for some specific types of impairments, until provisions to support whole school inclusive policies in regular schools can be provided. Lastly, other approaches are focused on providing additional funding for schools that include children with disabilities by allocating more resources and increasing incentives for enrolment.¹²²

How those left behind and 'furthest behind' are identified:

Many countries have standards by which they assess the education level of children at all levels of schooling. In many countries, detailed statistics are available at a school or even class level on students having difficulty in school or suffering from other disadvantages. In many cases though, in order to identify the furthest behind, household surveys or other methods are required. The UNESCO Institute for Statistics generates estimates of the number of out-of-school children from official administrative data for three age groups: children of primary school age and adolescents of lower and upper secondary school ages. Within each age group, only children in formal primary or secondary education are counted as in school.

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ANNEX 2

Methodology for Chapter 2

The methodology used in the analysis of the interlinkages followed the so-called 'realist review' method, which is considered a rigorous approach to analyse heterogeneous data emerging from various disciplines to identify relationships between different concepts.¹ The method comprises four elements (Figure A). The first step was a search for relevant information and scientific papers on topics relevant to the three areas covered in the nexus. That consisted of: 1) an initial map of the interlinkages assembled by the authors; 2) an electronic bibliographic search, which identified 201 relevant articles; 3) identification and outreach to 147 experts based on the authorship information available in those articles. Twenty-four experts provided inputs, including the identification of linkages and of another set of 97 relevant scientific articles; 4) outreach to experts within the United Nations System to collect relevant information about scientific research on the nexus; 5) outreach to experts outside the United Nations System to

collect information; and 6) bibliographic search of relevant articles that cited those scientific papers identified in the previous four steps.

Although broad, the resulting list of relevant articles can only be considered illustrative of the literature because, among other reasons, the search was mainly done in English language and most of the experts who replied to the invitation to contribute were based in institutions located in developed countries.²

Second, the team of primary reviewers selected a subset of relevant articles based on the inclusion criteria presented in Table A. The focus of the analysis was on studies focusing on the interrelations between the elements of the nexus and that provided empirical results. The third element was the extraction and compilation of relevant attributes, including the direction and magnitude of the interlinkages, measures used, and assumed channels through which one element of the nexus affects the other. The fourth step was the identification of patterns, links, most probable channels within the nexus and the gaps in knowledge.

Figure A. Main elements of the methodology

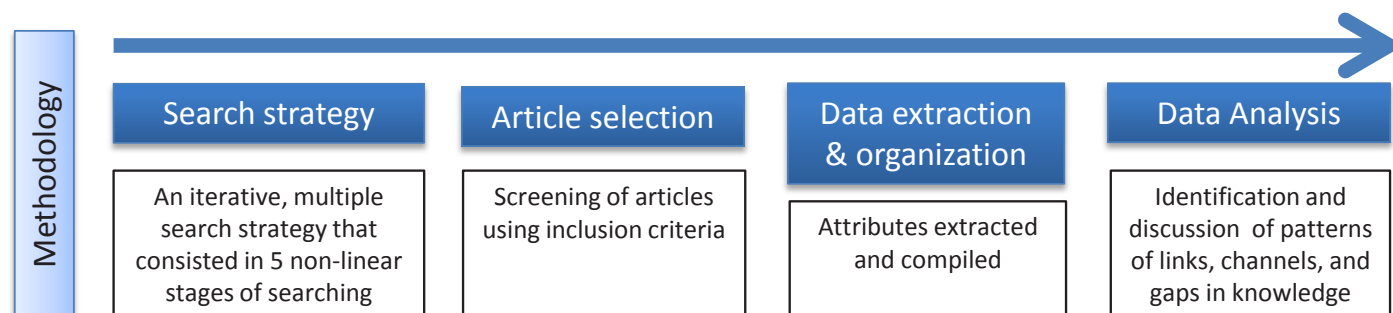


Table A. Inclusion criteria of scientific research

	Study focus and outcome	Study design
Includes	<ul style="list-style-type: none"> • Infrastructure policy, design, plan, provision in the areas of roads, ICT, electricity, water, sanitation, irrigation and its outcome related to inequality or resilience • Inequality and effects on infrastructure or resilience • Resilience design, plan and outcome related to infrastructure or inequality 	<ul style="list-style-type: none"> • Systematic reviews, meta-analysis, case studies, quasi-experimental studies, econometrics
Excludes	<ul style="list-style-type: none"> • Studies with focus and outcome in the same area (e.g. focus on inequality of income and outcome on inequality of health) • Proposal of methodologies to assess resilience or inequality • Studies that focus on other forms of infrastructure (e.g. housing, hospitals) • Resilience against conflicts and security-related shocks 	<ul style="list-style-type: none"> • Non-empirical studies • Estimate of impact of disasters • Editorial, commentaries, letters, opinion pieces

Source: Authors elaborations.

Endnotes

- 1 For an example of the use of the method see Kastner, M, Makarski, J, Hayden, L, Durocher, L, Chatterjee, A, Brouwers, M, & Bhattacharyya, O 2013, 'Making sense of complex data: a mapping process for analyzing findings of a realist review on guideline implementability', BMC Medical Research Methodology, 13, 1, pp. 1-8, Academic Search Premier, EBSCOhost, viewed 30 March 2016.
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ANNEX 3

Scientists' perspectives on crucial emerging technologies for the SDGs until 2030

Bio-technology

*Biotechnology, genomics, and proteomics*¹ are now major driving forces in the biological sciences and are increasingly being applied in the study of environmental issues, medicine and pharmaceuticals, infectious diseases, and modifications of food crops.

Bio-technology has the potential to lead to sustainable solutions for a range of sustainable development issues.² For example, genetically modified organisms could help address food insecurity in developing countries, but their impact on ecosystems, human health and community values may need to be better understood to be considered a truly sustainable solution.³ Experience has shown that deployment of such technologies needs to consider the local situations and possible trade-offs.⁴

Synthetic biology is a field of great promise and possible dangers. Tailor-made medical solutions, gene therapy, technology disruption in the food industry, bio-engineered medicines, and precise bio-inspired drug delivery systems that target specific infected cells - together with stem cells - give many promises. However, if inappropriately used, it could cause irreversible changes to human health and environment.^{5, 6, 7} Synthetic biology requires effective policies and frameworks to manage all stages of their lifetime, including manufacturing, distribution and use, as well as safe disposal or where possible effective recycling.^{8, 9, 10}

New and emerging gene-editing technologies and their implications, benefits, and potential ethical problems for biotechnology and medicine have generated international scientific debate, with recommendations to establish norms concerning acceptable uses of human germline editing and harmonize regulations.¹⁰ Genuine "human engineering" may not be far off in the future, when technologies related to gene-editing, stem cells and computational models of the human brain will be combined.

Digital technology

Digital information and communications technologies (ICTs) have continued to rapidly advance. All parts of the world are now major users. Mobile phone ownership in Africa is now comparable to that in the USA, with about one connection per capita. Yet, while some digital gaps have closed, others continually open with the introduction of new technologies. In the context of implementing SDGs in Africa, information and communications technologies may play a role comparable to that of machines in the replacement of labour in the industrial age.¹¹ However, whereas the machines of the industrial era functioned as

isolated and individual artefacts in one local environment, ICTs and knowledge creation exist as a hierarchy of networks that bring about innovations.^{12, 13}

Great technology potential has been accompanied by equally great concerns about social, political, economic and environmental impacts. The new fifth generation (5G) mobile phones enable vastly faster data connections than traditional phones. The "Internet of Things" is emerging and it interconnects physical objects to internet infrastructure. 3D printing enables the making of three-dimensional objects from a digital file, and together with robotics it has the potential to significantly alter the geographical distribution of manufacturing with important impacts on global labour markets and imbalances. "Big data" technologies transform the way governments, citizens, and companies do business, but they have led to concerns about erosion of privacy and freedom of expression. Similarly, wireless sensor networks have great efficiency potentials in many areas, but there are concerns about their impact on privacy, freedom and development.

Big Data and the Internet of Things through the use of huge datasets and Internet-connected sensors potentially adds to the existing toolkit for sustainable development (e.g., in health, agriculture, food security, sustainable urbanization, etc.), but can also introduce risks related to data privacy and security. Because of cloud computing platforms that provide low-cost access to compute and storage capabilities as well as Free and Open Source Big Data and Internet of Things technologies, such technologies can serve as platforms for locally-relevant, pro-poor innovation without significant capital investments. However, this requires the requisite local talent to tailor solutions to local needs. National governments must also consider the limits of big data analysis (especially for causal inference and policy analysis), how such technologies can serve existing national development planning, regulatory frameworks for securing the rights of citizens with respect to privacy and security, and strengthening human capital and the larger ecosystem to effectively use such tools.¹⁴

"Big data" has transformed the volume, velocity, and character of the information that we are able to procure regarding virtually every aspect of human life.¹⁵ Online participatory tools increasing transparency and accountability in global sustainable development governance allow greater access to sharing of substantive information on the issues addressed by the civil society, international organisations and member states for realization of agenda 2030.¹⁶ At the same time, the scientific community highlighted the idea that the most sustainable way to bring the deepest results of the digital revolution to developing communities is to enable them to participate in creating their own technological tools for finding solutions to their own problems.¹⁷

3D Printing (3DP) can cost-effectively lower manufacturing inputs and outputs in markets with low volume, customized and high-value production chains. It could potentially help countries and regions that did not participate in the industrial revolution develop new manufacturing capabilities, especially for low volume, highly complex parts. Applications range from automobile and aerospace manufacturing to rapid-prototyping, healthcare, and education. Low cost consumer 3DP printers can help local people in developing and developed countries to produce a range of useful products, from basic assistive technologies to educational aids. For example, the projects of the Rapid Foundation in India and Uganda have shown that low cost printers are easy to build, use, fix or modify and are robust in remote locations. With expert training, anybody can become comfortable with using these printers in a few hours.¹⁸ Further low-cost applications in science, education and sustainable development are detailed in a recent ICTP open book.¹⁹

3D printing presents a number of challenges, including possibly disrupting existing manufacturing global value chains, decreasing labour demand for housing and construction, and potentially enabling the physical production of illegal 3D models that could pose both economic and security threats. There are potential environmental benefits (lower energy use, resource demands and CO₂), if 3D printing displaces existing transportation and logistics routes for shipping of goods and products. A recent study concluded: "If 3DP was applicable to larger production volumes in consumer products or automotive manufacturing, it contains the (theoretical) potential to absolutely decouple energy and CO₂."²⁰ However, as 3DP is expected to remain a niche technology by 2025 reductions in energy and CO₂ emission intensities of industrial manufacturing could only be reduced by a small factor through 3DP by that date.

Massive Open Online Courses potentially provide resource-poor regions and individuals more equitable access to world-class education content. Widespread global Internet access is impacting how we learn, as seen in the availability of various online learning platforms such as massive open online courses (MOOCs).²¹ With low-cost replication of recognized content and education, personalized, self-paced learning, and interactive data-driven user interfaces, students potentially have access to material that previously would have been out of reach. However, MOOCs may not provide locally-relevant content tailored to a specific national context. Furthermore, MOOCs could replace the jobs of existing teachers and widen existing educational divides (i.e., providing a disproportionate advantage to individuals with access to the Internet and education). One nonprofit university based in Rwanda combines online learning content with in-person seminars to deliver degree programs that are locally-relevant, appropriately priced,

and stimulate local employment. At this point, the potential impact of MOOCs requires more study, both globally in terms of existing platforms as well as of users in specific national contexts, along with implications for educational systems and employment.

Optimal system use of radio, mobile phone, GIS and remote sensing technologies is considered vital for transforming rural populations.²²

The use of GIS to monitor an ever wider array of parameters at ever higher spatio-temporal resolutions allows us to consistently and constantly measure and monitor a huge array of environmental factors, allowing the enforcement of regulations, which would otherwise be impossible.^{23, 24}

Yet, *data management* remains a challenge for many countries, as they lack both skilled staff and technologies for effectively collecting or reporting reliable data. Many of the commonly used spatial database platforms are proprietary and are too expensive for many organizations in developing countries.²⁵

Nanotechnology

*Nanotechnology*²⁶ is a field of enormous promise and big challenges. It is reported to have high potential for increasing innovation for sustainable development in the energy, water, chemical, medical and pharmaceutical industries.²⁷ *Nanoimprint lithography* is expected to lead to large-scale manufacturing of nanotechnology products with various positive and negative sustainable development challenges. Nano-products might revolutionize many fields including medicine, electronics, energy and water, as well as food industry in the coming years. At present, there are high expectations about high-performing nanomaterial solar cells and nano-technology applications for decentralized water and wastewater treatment, and desalination.²⁸ Recently, scientists in Singapore have demonstrated converting CO₂ into methane using light and amine-functionalized titanium dioxide nanoparticles – this would allow storing intermittent solar energy in the form of natural gas which could then be burned in a carbon neutral way.

The implications of unethical and uncontrolled use of nanotechnology have created an ongoing debate in the scientific community around concerns about their toxicity and environmental impact (e.g., nanowaste).^{29, 30, 31} The OECD and IUCN are currently working with several governments to develop suitable and efficient regulations and policies, and urge a more unified and collaborative approach at all levels to address this potentially hazardous issue through experience- and knowledge-sharing, coordinated research activities, development of guidelines for producers, users and waste-processing facilities^{32, 33} and examination of existing guidelines or policies.³⁴

As nanotechnology can be damaging to environment and human health, it requires effective policies and frameworks to manage all stages of their life-time, including manufacturing, distribution and use, as well as safe disposal or where possible effective recycling.^{35, 36}

There are many promising future, inorganic and organic nanomaterials. Examples include perovskites, gold nanoparticles, graphene, carbon nanotubes, carbon nanodots and conducting polymers. *Carbon based nanomaterials* are very interesting as they rely on abundant carbon and have much potential as high performance substitutes for many materials that are scarce and highly resource intensive in their extraction process. *Iron, cobalt, and nickel nanoparticles can be alternatives to scarce metals* like platinum, rhodium, and gold *for catalysis*. For example, layered iron and nickel nanomaterial are a more sustainable alternative to rare-earth “supermagnets”.

Neuro-technology

Smart technologies will be crucial technologies until 2030 and beyond. They will help societies to monitor, detect as well as respond or adapt to changes in their environment. Smart technologies are already and will become a part of our daily lives.³⁷ For example, smart electricity metering has addressed the problem of the losses of electricity due to theft.³⁸

Emerging technologies in the area of artificial intelligence have received much attention in which computer systems that carry out tasks normally done by humans, such as speech recognition and decision making. Another example is *robotics* which is understood as machines or mechanical systems that automatically handle tasks.

*Mesoscience*³⁹ *powered virtual reality* gives us the possibility to realize the logic and structural consistence between problems, physical models, numerical methods and hardware, which, together with the dramatic development of computing technology, is opening a new era for virtual reality.

Digital Automation characterizes the increasing ability of computers to overtake cognitive - and not just physical - tasks, enabling recent innovations like driverless cars, IBM Watson, e-discovery platforms for legal practice, and personalization algorithms for Web search, e-commerce, and social networks. The *potential consequences of automation and artificial intelligence on employment* are emerging areas in need of examination; the expansion of computing and machine intelligence is likely to affect healthcare, education, privacy and cybersecurity, and energy and environmental management. Recent studies are pointing to the possibility that a significant number of jobs - or job tasks - are amenable to automation, leading to a job polarization where demand for middle-income jobs

are reduced while non-routine cognitive jobs (e.g., financial analysis or computer programming) and non-routine manual jobs (e.g., hairdressing) would be less unaffected. At this point, more study is warranted to understand implications for employment and socio-economic development in a specific national context.

Autonomous vehicles or self-driving cars hold the promise to increase traffic efficiency, productivity, reduce traffic congestions and pollution, and save driving time. In 2016, the Dubai Autonomous Transportation Strategy was launched which foresees 25 per cent of all trips in Dubai to be driverless by 2030. The Autonomous Transportation Challenge as launched as a request for proposals to global R&D centres to apply this technology in Dubai. It will make Dubai the world's largest R&D lab for driverless transportation.⁴⁰

Green technology

Green technology refers to environmentally sound technology. Existing technologies as well as new nanotechnology, biotechnology, and digital technology may all be deployed in new ways to reduce non-renewable resource use and to utilise and support ecosystem processes.

Technology change in the energy and materials sectors are key.⁴¹

In the energy sector of developed countries, crucial technologies suggested by experts include smart grids, highly energy efficient buildings, electric vehicles, vastly improved and cheap batteries, nuclear power, hydrogen-fueled vehicles and supply infrastructures, and natural gas technologies. In developing countries, they included new ways of electrification, desalination based on reverse osmosis, small and medium sized nuclear reactors, and mini-grids based on intermittent renewables with storage.⁴²

Cheaper and highly energy efficient fossil fuel power plants will be needed. Highly efficient vehicles including hybrid cars and intelligent transport systems (ITS) technologies for controlling traffic flows will be important.^{43, 44} Large-scale deployment of solar power, and technologies to replace aluminium and other high impact materials are equally important.⁴⁵ Salinity gradient power technology could potentially produce 80 per cent of the global energy demand.⁴⁶ Passive housing technology could make a big difference in energy use, as it results in ultra-low energy buildings that require little to no energy for space heating or cooling.

Decentralized electric power systems are expected to play a very important role in coming years, especially for ensuring that no one is left behind. To this end, RD&D is needed in such systems (efficient appliances, intermittent

supply solar, wind) and in interactions with heat pumps for space heating, heat and power storage and electric mobility. Innovative community and business models will be needed to operate such systems in terms of reliability, affordability, sustainability and safety and privacy. Another component of this emerging technology system will be integrated urban and rural mobility, notably a well-functioning public transport infrastructure, new mobility options (e.g., e-bike, e-car, greenwheels) and in some areas biofuel supply chains.⁴⁷ Hence, deployment of off-grid electricity systems and even direct current can be a core solution to achievement of the SDGs.^{48, 49} They should be given ample research funding.^{50, 51} For example, off-grid electricity could be used to dry grain⁵² and to store and transport perishable food,⁵³ in order to reduce food wastage.^{54, 55} Institutional innovation does not only promote the development and deployment of technologies, but also provides the foundations for paradigm shift. In China, block tariff of household electricity consumption accelerated replacement of incandescent fluorescent lamps with LED lamps. Feed-in pricing of wind-power and solar PV are thought to have contributed to make China the country with highest increase in and the largest installed capacity of wind and solar PV in the world.^{56, 57, 58}

Cookstoves with the emissions comparable to those of an LPG stove would play an important role in the achievement of the SDGs, given the enormous and multiple benefits that could come from the large-scale deployment of such a stove.^{59, 60} Globally, more than 2 billion people rely on traditional use of biomass fuels for cooking and heating and have limited access to clean and efficient energy for lighting. Increasing access to clean and efficient cookstoves and fuels can also ensure lasting, inclusive gains in the areas of poverty eradication, food security, health and well-being, education, gender equality, economic growth, reducing inequalities, sustainable cities, environmental protection, and climate change mitigation. Effective deployment of these technologies requires substantial engagement of women. Developers need to put female users at the center of their concepts, design and deployment stages.⁶¹

Technologies for pollution purification will be of the utmost importance until 2030. New technologies for detection and removal emerging contaminants in stormwater, for drinking water, and wastewater treatment and reuse are emerging. In the future, every gasoline-powered motor vehicle would be equipped with emission purification plant, and polluting enterprises would be installed with comprehensive purifying equipment. Meanwhile, environmentally-friendly energy would be widely used in diverse industries.⁶²

New technologies are emerging that support a transition to a circular economy.⁶³ These include technologies for remanufacturing, technologies for product life-

cycle extension such as re-use and refurbishment, and technologies for recycling.⁶⁴ Social innovation will also play an important role. The level of performance and deployment will depend on material streams and the specific context. Proposed by the EU Circular Economy Package of December 2015, a recycling rate of 65 per cent for municipal solid waste may be achievable by 2030.⁶⁵

Technological advancement should foster an urban metabolism that is sustainable in itself not dependent on other regions for the supply of resources and the discharge of waste.⁶⁶ In this direction, new recycle and reuse technologies and multifunctional infrastructures play a pivotal role. Technologies for integrating centralized systems and decentralized systems for provision of services such as energy and potable water are also emerging.^{67, 68, 69, 70, 71}

A whole range of new *deep sea mining technologies* are emerging, but many of them are not yet commercially viable. These technologies could have greatly impact sustainable development, in view of their impacts on global resource use and their potential benefits for island nations.⁷²

The production of food for half of the world's population continued to depend on fertilisers made by fixation of nitrogen through the Haber-Bosch process. Technologies for nitrogen fixation that are less energy intensive and that avoid very high H₂ pressure would be highly desirable. *Advances in bio-organometallics and materials chemistry are greatly increasing the efficiency of biomimetic analogs of nitrogenase*, a natural enzyme that can fix atmospheric nitrogen at room temperature and pressure without the need of molecular hydrogen.

Improvements in geophysical research and seismic exploration of the ocean floor, through the application of *marine Vibroseis (MV)*, show potential in providing an environmentally safer alternative to airguns, which have negative effects on marine animals.⁷³

Artificial photosynthesis is close to commercialization. It is now possible to produce different carbohydrates directly from CO₂ and water using merely sunlight. Artificial leaves, when immersed in water, directly produces hydrogen and oxygen. These leaves consist of wireless, low-cost, thin film amorphous silicon multi-junction cells.⁷⁴

Endnotes

- 1 *Biotechnology* means the use of genetic engineering and its associated techniques. *Genomics* is the study of the genomes of organisms, i.e., the complete set of DNA within a single cell of an organism. *Proteomics* is the large-scale study of proteins, particularly their structures and functions.
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ANNEX 4

Selected studies analysing NCSDs

Study	Main topic covered
The Earth Council (1997), A Vision and Practical Measures for National Councils as Effective Mechanisms for Sustainable Development, Annex 1. ¹	The report is the outcome of the National Councils for Sustainable Development working group at the Rio+5 meeting held in Brazil. It gives recommendations for future strengthening of the NCSDs.
UNECLAC (2000), Sustainable Development Latin American and Caribbean Perspective. ²	The report takes stock of regional experiences in sustainable development implementation.
UNECA (2005), National Councils for Sustainable Development in Africa: A review of Institutions and their Functioning, Addis Ababa ³	The report takes stock of established NCSDs in Africa and their operations, in the context of the requirement for a balanced integration of the economic, social and environmental dimensions of sustainable development.
Niestroy, I. (2007): Stimulating informed debate – Sustainable Development Councils in EU Member States. A compilation of tasks, capacities, and best practice. ⁴	Commissioned by the German Council for Sustainable Development (RNE), the paper explores two tasks and functions allocated to the sustainable development councils in EU Member States by the EU SDS of 2006, namely stimulating informed debate on SD and involving civil society.
Berger, G. and Steurer, R. (2009), Horizontal policy integration and sustainable development: conceptual remarks and governance examples, ESDN quarterly report, June 2009.	The report explores the meaning of horizontal policy integration in the context of sustainable development. It highlights how the functioning of public administrations may stand in the way of this objective, and what governments can do to overcome existing barriers.
Busch and Jorgens (2009), Governance by diffusion. International environmental policy coordination in the era of globalization, Dissertation, FU Berlin, 2009.	The paper explores systematically the aptitude of diffusion as a distinct mode of international policy coordination, its functioning and its relative importance compared with other, more centralized steering mechanisms.
Niestroy, I. (2012), Sustainable Development Councils at National and Sub-national Levels Stimulating Informed Debate: Stocktaking, Stakeholder Forum Sdg2012. ⁵	The paper aims to provide useful lessons learned on NCSDs. It focuses on the purpose, composition and functions of NCSDs, and reviews common trends and best practices.
Cornforth, J., I. Niestroy and D. Osborn (2013): The governance of scaling up successful sustainability practices: How can National Councils for Sustainable Development organise the wider use of national and regional examples? ⁶	The paper discusses the governance of scaling up, looking at different factors which affect the transferability of successful practices and explores examples of mechanisms for scaling up that could be used by the NCSDs.
Osborn, D., Cornforth, J. and Ullah, F., (2014), National Councils for Sustainable Development: Lessons from the past and present, Stakeholder Forum. ⁷	The report draws on a survey focusing particularly on countries where NCSDs have been seen to function well in order to try to identify best practises and success factors.
Olsen, S.H. and Zusman, E. (2014), Governance and National Sustainable Development Strategies, Institute for Global Environmental Strategies (IGES) Policy Report. ⁸	Lessons learned from five detailed cases from Asia, namely, Thailand, Indonesia, Philippines, Republic of Korea, and Bhutan.
De Vries, M. (2015), The Role of National Sustainable Development Councils in Europe in Implementing the UN's Sustainable Development Goals: Overview and Conclusion, Background Paper commissioned by the German Council for Sustainable Development (RNE) and EEAC. ⁹	The report analyses the main challenges tasks, and functioning of National Sustainable Development Councils in Europe, and their capacity for participating effectively in the SDG implementation.
Niestroy, I. (2015), Governance approaches and tools for SD integration: good practice (what has worked where and why) at national level, paper for the UNDESA/UNEP Technical Capacity Building Workshop Sustainable Development Integration Tools, Geneva, 14-15 October 2015	The paper presents key steps to take for translating the SDGs in national policies and processes and highlights key governance principles and respective integration approaches.

Source: Authors' elaboration.

Endnotes

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ANNEX 5

Examples of emerging issues processes/mechanisms undertaken by UN agencies

Entity and description	Issues
<p><i>Food security and nutrition</i></p> <p>The High Level Panel of Experts on Food Security and Nutrition (HLPE) was established in 2010 as the science-policy interface of the United Nations Committee on World Food Security (CFS).</p>	<p>A 2013 Note on emerging issues in the context of FSN highlighted four challenges: (a) many disciplines involved in the identification and framing of issues, and many different ways to relate them to the four dimensions of food security; b) issues can emerge specifically due to increased interdependencies between, e.g. agriculture and other sectorial issues such as transportation; c) issues can emerge in the future, therefore, requiring foresight tools; and d) contexts change and issues vary, which calls for regularly revisiting them.</p> <p>Participants surveyed were asked to provide in-depth disaggregated information on the effect the emerging issue they put forward had in terms of the number affected, their geographical location, gender and vulnerable group. This aspect of the methodology was already in line with the main premise of the 2030 Agenda of “leaving none behind.”</p> <p><i>Recent completed reports:</i> Water for food security and nutrition (2015), Food losses and waste in the context of sustainable food systems (2014), Sustainable fisheries and aquaculture for food security and nutrition (2014). <i>Underway:</i> Sustainable agriculture development for FSN, including the role of livestock (2016), Sustainable forestry for food security and nutrition (2016).</p>
<p><i>Environment – UNEP</i></p> <p>UNEP’s Emerging Issues Project has identified ten major issues of focus in the year 2015/16 based on the regional and policy relevance, urgency, evidence and newness.</p>	<p>The issues are: 1. Marine plastics and biodegradability; 2. Micro-beads and Cosmetics; 3. Emerging Zoonotic Diseases; 4. Drought and Plant Toxicity; 5. Soil Carbon and Valuation; 6. Loss and Damage; Water Risk Financial Share Pricing; 8. Dust and Sandstorms and Desertification; Illegal Wildlife Trade; 10. New Materials and 3D Printing</p>
<p><i>Marine environmental pollution – GESAMP</i></p> <p>Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) is an advisory body established in 1969 and consisting of specialized experts nominated by nine Sponsoring United Nations Agencies, namely IMO, FAO, UNESCO-IOC, UNIDO, WMO, IAEA, UNEP, and UNDP. GESAMP’s principal task is to provide scientific advice concerning the prevention, reduction and control of the degradation of the marine environment to the Sponsoring Agencies.</p>	<p>GESAMP’s New and Emerging Issues Programme - At its 2015 session, the impact of residues of chronic oil spills in the marine environment was raised as an issue of particular concern. GESAMP was called to carry out a study on disinfection by-products and biofouling to add further knowledge on the subject matter (Report of the 42nd Session of GESAMP, 2015).</p>
<p><i>Science - UNESCO</i></p> <p>Science Report mapping science, technology and innovation (STI) produced annually for the past twenty years. The 2015 UNESCO Science Report: towards 2030, analyses trends and developments in science, technology and innovation policy and governance between 2009 and mid-2015, with a view to providing essential baseline information on the concerns and priorities of countries that should orient the implementation and drive the assessment of the 2030 Agenda.</p>	<p>2015 Report contains chapter on Perspective on Emerging Issues with five articles (a) the increasingly global role universities play, including related opportunities such as educational partnerships, explosive growth in brain circulation, and the digital disruption, while the need to close the innovation gap is identified as among the challenges; (b) increased interconnectedness of the second generation World Wide Web and open science that has helped develop a modern approach to science through information-sharing and data-reuse; (c) the critical role science will have in implementing the 2030 Agenda and the need for an integrated approach to achieve this; (d) the need for a new framework for global science policy, and (e) the contribution of local and indigenous knowledge to the science-policy interface.</p>
<p><i>Disaster risk – UNU-HIS</i></p> <p>United Nations University – Institute for Environment and Human Security (UNU-EHS) and the Alliance Development Works/Bündnis Entwicklung Hilft (BEH) publish the annual World Risk Report, which systematically considers a country’s vulnerability, and its exposure to natural hazards to determine a ranking of countries around the world based on their disaster risk.</p>	<p>The 2015 report examined the connection between food security and disaster risk, drawing on the report’s World Risk Index. One of the recommendations of in the report is that investment in food security should be designed in such a way that the vulnerability of societies towards disasters is lowered. Previous reports have considered Cities as an area of risk (2014) and Health and Healthcare (2013).</p>

Annex 5: (continued)

Entity and description	Issues
<p><i>Digital dividends – World Bank</i></p> <p>The World Development Report 2016, entitled Digital Dividends, analyzes the contribution of digital technologies to development. Noting their rapid spread throughout the world, it also recognizes that the broader development benefits from using these technologies have lagged behind.</p>	<p>The WDR 2016 also examines six nascent or emerging technologies that promise to be far-reaching in their impact on development. They are: fifth generation (5G) mobile phones, with vastly faster data connections than existing phones; artificial intelligence, computer systems that carry out tasks normally done by humans, such as speech recognition and decision making; robotics, understood as machines or mechanical systems that automatically handle tasks; autonomous vehicles, or self-driving cars; the internet of things, which refers to the interconnection of objects to internet infrastructure; and 3D printing, a process that enables to make three-dimensional objects from a digital file.</p>
<p><i>UN Secretary-General's Scientific Advisory Board (UN-SAB)</i></p> <p>In December 2014, the UN Secretary-General invited the UN-SAB to identify for his consideration "scientific concerns about the future of people and the planet." The Board responded by conducting a Delphi study to identify the top challenges for the future of humanity and the planet, identifying "big ideas" to be brought to the attention of the Secretary-General and for him to seek a global response.</p>	<p>The result was the list of top eight challenges presented in this brief for consideration by the UN Secretary-General. These Top Eight Challenges were: one ocean, many countries: building a "blue economy" sustainably, addressing threats to biodiversity and establishing a new paradigm for the global tropics, putting in place a comprehensive strategy against infectious agents, including a global system for immediate response, ensuring investment, as a fraction of GDP, in basic research and basic science education, averting enormous human disasters through prediction, emissions free technology: changing the fossil fuel paradigm, providing drinking water for all, finding solutions for a world overwhelmed by unequal resource use and continued population growth.</p>
<p><i>Intergovernmental Oceanographic Commission (IOC) of UNESCO</i></p> <p>The purpose of the Commission is to promote international cooperation and to coordinate programmes in research, services and capacity-building, in order to learn more about the nature and resources of the ocean and coastal areas and to apply that knowledge for the improvement of management, sustainable development, the protection of the marine environment, and the decision-making processes of its Member States.</p>	<p>An international group of ocean oxygen scientists investigating the threat of deoxygenation globally, supported by IOC-UNESCO, summarized 10 major ocean oxygen issues: increasing temperatures will reduce the capacity of the ocean to hold oxygen in the future; oxygen deficiency is predicted to worsen in estuaries, coastal areas and in oxygen minimum zones in the open ocean; the ocean's capacity to produce oxygen will be reduced in the future; habitat loss is expected to worsen, leading to vertical and horizontal migration of species; oxygen deficiency will alter biogeochemical cycles and food webs; lower oxygen concentrations are projected to result in a decrease in reproductive capacity and biodiversity loss; there are important local decreases of commercially important species and aquaculture production; harmful algal blooms might be stimulated by nutrients released in bottom waters due to hypoxia; reduced ocean oxygen concentrations will lead to an increase in greenhouse gas emissions, thereby initiating feedbacks on climate change; future scenarios for oxygen depend on a combination of drivers related to global environmental change and land-use, which, in turn, act together in affecting marine ecosystems – thus, a multi-stressor approach is important.</p>

Source: Authors' elaboration.

Examples of emerging issues placed within a frame of broader underlying issues: expanded matrix

Emerging Issue	Value to be Sustained	Threats	Opportunities	Causal mechanisms	Responses/Actions	Key Emerging Features
Coping with the increasing impacts of climate changes.	<ul style="list-style-type: none"> Sustainable development 	<ul style="list-style-type: none"> Threat to global: <ul style="list-style-type: none"> Infrastructure Migration Agriculture Environment Biodiversity Etc. Asymmetrical effects of climate change will harm LDCs most as they are most susceptible to risk 	<ul style="list-style-type: none"> Employment of modern energy systems will lead to CO₂ emissions reductions Reduction of emissions gap between countries Development of scientific methods strengthens global economy 	<ul style="list-style-type: none"> 2030 Agenda will not be achieved at the current political pace Slow advancement due to unfamiliarity of collaboration between scientists and politicians 	<ul style="list-style-type: none"> Expansion of communication and infrastructure between stakeholders on all levels Unrecorded/undiscovered CO₂ emissions (sources) to be added to calculations Need of political symmetry Early warning training for countries at risks Financing of big data for remote and developing regions with public access in local languages Response examples from positive cases for stakeholders as mitigation tool 	<ul style="list-style-type: none"> Time lag between political action and impacts of climate change under expediting effects; outpacing climate change relative to expectations and response rate Certain threats have not yet been discovered and in turn mechanisms cannot be formulated yet to avoid them The absence of big data stalls political action
Food, water, and energy nexus.	<ul style="list-style-type: none"> Food and water security Economic, environmental and social stability Energy transition towards decarbonized world 	<ul style="list-style-type: none"> New knowledge on agricultural technology present in the private sector is subject to patents and leads to unavailability of essential knowledge Renewable energy is subject to economic viability; decreasing oil prices make renewable energy less attractive for investors Water pollution and waste water mismanagement 	<ul style="list-style-type: none"> Harvesting rainwater could ensue water and food security Improving way of water harvesting for agriculture will increase agricultural output Wide scale distribution of clean fuels and energy technologies Increase rate of renewable energy More policy framework for integrated landscape management 	<ul style="list-style-type: none"> Initiate developing countries to refocus on rural areas, as they are often overlooked in the strive towards development Exposure of interlinkage between poverty and water access to fund acquisition of underground water sources in developing countries Synthetic protein as response to food insecurity Foster individual voice and agency in underrepresented populations Direct integration of women along the clean energy value chain and food and sanitation programs 	<ul style="list-style-type: none"> As renewable energy has difficulty competing with market prices, it becomes and emerging issue Climate change accelerates food and water insecurity in developing countries most susceptible to risk 	
The need to develop alternative economic models that decouple economic growth resource use and minimize environmental degradation.	<ul style="list-style-type: none"> Social inclusion and environmental protection 	<ul style="list-style-type: none"> Current economic growth models avoid sustainability as a factor because economic advantages of sustainable development is not realized 	<ul style="list-style-type: none"> Taking sustainability into account would allow an environmentally feasible development Pricing sustainability would accelerate the development of sustainable energy due to increased investments 	<ul style="list-style-type: none"> Financing of alternative economic models that prognosticate positive effects of sustainability will increase further investments and funds for economic models 	<ul style="list-style-type: none"> Dimension of pricing sustainability needs to be added to models to highlight economic advantages of sustainable development, i.e. income from waste management Addition of behavioural, cognitive change in every-day life and in models Make transition attractive to overcome fear of cost Promote green jobs and greater resource efficiency 	<ul style="list-style-type: none"> Sustainable development can be economically advantageous, but is not portrayed as such in economic models yet and thus influences allocation of funds negatively with regards to sustainability

Annex 6: (continued)

Emerging Issue	Value to be Sustained	Threats	Opportunities	Causal mechanisms	Responses/Actions	Key Emerging Features
Persistence of poverty globally, including the poor in rich countries; Highly unequal distribution of household wealth across and within nations, including gender equality.	<ul style="list-style-type: none"> Moral issue 	<ul style="list-style-type: none"> Less social cohesion Various humanitarian issues Unemployment Poor are falling further behind in rich countries, where a strong middle class limits the opportunities of the lower classes Within developing countries increased regional disparities between remote and urban areas 	<ul style="list-style-type: none"> Enhanced services for poor people to close poverty gap Strengthening behavioural interventions building upon cutting edge psychological and social innovations 	<ul style="list-style-type: none"> Emerging technologies may not be as costly as economists have predicted Examples have demonstrated the viability of sustainable pathways 	<ul style="list-style-type: none"> Education, training, skills development and social services, especially for females as they are most vulnerable Re-examination of poverty indicators Deploy technology to all sectors Transparency in political action needed; inclusive agenda apply big data to overcome poverty or support poverty education/poverty mapping Strengthen labour market institutions and social protection systems 	<ul style="list-style-type: none"> Growth no longer guarantees reduced unemployment and poverty
Integrated assessment of sustainable development pathways.	<ul style="list-style-type: none"> Sustainable development 	<ul style="list-style-type: none"> Lack of understanding sustainable pathways will hinder sustainable development and increase the effects of all related threats 	<ul style="list-style-type: none"> Existing system may not be efficient, but must be extended and take into consideration sustainable development 			
The depletion of ocean fish stocks and the exploitation of marine resources.	<ul style="list-style-type: none"> Healthy ecosystem Intrinsic value (biodiversity) Food security 	<ul style="list-style-type: none"> EEZ: 200 Nordic miles around the coastline which country has control over (can be an opportunity) Over-fishing Ecosystem depletion IRU fishing Pollution has a negative effect on fish stock and the ecosystem; the contaminated fish stock will negatively impact consumers Exploitation of the deep sea 	<ul style="list-style-type: none"> EEZ as opportunity for sustainable management Food security Economic growth 	<ul style="list-style-type: none"> Emerging technologies may not be as costly as economists have predicted Examples have demonstrated the viability of sustainable pathways 	<ul style="list-style-type: none"> A forum for global marine policy Extend focus on delta areas, as they will be highly affected in the future Involve land-locked countries in decision-making processes Make mechanisms for renewable energy available for developing countries Dissemination Technology for monitoring EEZs needs to be made available for developing countries to limit illegal fishing Need to consider fish migration in the face of climate change Aquaculture has environmental impacts and positive effects that need to be calculated against each other for the individual case 	<ul style="list-style-type: none"> High seas have territorial issues making sustainable development highly difficult Marine ecosystem depletion will enable food insecurity, health threats, and further unknown consequences

Annex 6: (continued)

Emerging Issue	Value to be Sustained	Threats	Opportunities	Causal mechanisms	Responses/Actions	Key Emerging Features
Migration and all forms of movement of people across borders due to changes in demographics, weather patterns, and other causes.	<ul style="list-style-type: none"> • Social security and stability • Exchange of culture, knowledge and expertise 	<ul style="list-style-type: none"> • Social disruption • Pressure on economic and social systems, as well as the environment • “Brain drain”; draining countries of educated, highly-skilled individuals weakens the economy 	<ul style="list-style-type: none"> • Application of missing expertise provided by migrating individuals • Individuals can overcome poverty if their expertise is financed in another country • Language and culture as positive influence on economy 	<ul style="list-style-type: none"> • High speed of migration hinders sustainable reaction • Integrated, approach can build up economy from a local to a global scale 	<ul style="list-style-type: none"> • Future coastlines as method for strategic regional planning • Formulating a global migration law • Consider cross-border migration as well as local • Migration as a response to risk as indicator • Different drivers for lower-, middle-, higher-skilled immigrants • “Wins-wins” present in migration should be highlighted • Identify new factors of migration • Expertise in cultures and different language skills can be positively exploited by host nations/economies 	<ul style="list-style-type: none"> • Migration today is emerging under different parameters of economic, political, environmental, and social risk
Political instability and social unrest from increased income and wealth inequalities (Rephrase: The interplay between peace and sustainable development).	<ul style="list-style-type: none"> • Peace • Addressing general inequality and conflicts • Structural balance 	<ul style="list-style-type: none"> • Political instability and social unrest • Threats to overall well-being • Violence • Unjust situations 	<ul style="list-style-type: none"> • To preserve peace 	<ul style="list-style-type: none"> • Increased income inequalities • Widespread unemployment • Geopolitical rivalries • Competition for resources 	<ul style="list-style-type: none"> • Building an underlying framework to reduce conflicts • Reducing conflicts for sustainable development • Justice reinvestment: redirecting resourcing • Invest in prevention and in research • Strengthen labour market institutions and social protection systems 	<ul style="list-style-type: none"> • Political instability has become more emerging • Shift of resources and associated conflicts • Integrated and engaged approach to sustainable development would lead to redirection of investment
Putting in place the blend of governance forms and approaches required for the 2030 Agenda.	<ul style="list-style-type: none"> • The essence of good governance should be sustained 	<ul style="list-style-type: none"> • Type of government in place does not function well for complex, sustainable issues due to its vertical properties 	<ul style="list-style-type: none"> • Opportunity in reasserting control due to the rapid change in environment and the fast paced action needed to control the effects • Opportunity to put mainstream SDG knowledge into policy processes 	<ul style="list-style-type: none"> • Politicians have the incentive to respond with policies since effects of environmental change could occur as soon as during their own term 	<ul style="list-style-type: none"> • Government actions consistent with government aspirations • Cross-governmental action/mechanisms • Other stakeholders should be involved in implementing the agenda, decentralizing the decision making process • Sectors have different incentives that need to be considered when formulating policies • Integrating accountability • Formulate mutual aid responses for natural disasters and hazards • Inform public/consumer about ongoing environmental risks to empower them 	<ul style="list-style-type: none"> • Acceleration of impacts forces rapid responses on the political level • Effects of global changes do not stay within national boundaries, demanding a blend of governance forms and approaches

Annex 6: (continued)

Emerging Issue	Value to be Sustained	Threats	Opportunities	Causal mechanisms	Responses/Actions	Key Emerging Features
Institutional mechanisms and partnership.	<ul style="list-style-type: none"> Political stability and accountability 	<ul style="list-style-type: none"> Usage of "governance" Accountability: multiple relationships of accountability; societal accountability 	<ul style="list-style-type: none"> Involve broader institutional network outside sources 	<ul style="list-style-type: none"> Bedding down institutions in order to do action Institutions are a necessary condition to do anything 	<ul style="list-style-type: none"> Governments should not only be involved but also allow civil societies to play the actions. Establish governance mechanisms for the SDGs, from global to regional, national and local levels 	<ul style="list-style-type: none"> Inclusive institutional arrangements Action from non-centralized control Broader stakeholder engagement Public awareness: societal engagement
The need to protect and restore ecosystems.	<ul style="list-style-type: none"> Ecosystems & ecosystem services 	<ul style="list-style-type: none"> Increasing impacts of climate change Depletion and exploitation Migration Contaminations Urbanization 	<ul style="list-style-type: none"> Decrease inequalities and combat environmental degradation and climate change Develop alternative economic models The potential benefits of mapping local knowledge for climate change mitigation and adaptation purposes 	<ul style="list-style-type: none"> Time lags between scientific findings and policy action Poor understanding of ecosystems in some parts of the world Competition for natural resources 	<ul style="list-style-type: none"> Enhance social and environmental protection in developing countries Integrated and deliberative assessment of sustainable development pathways Putting in place the blend of governance forms and approaches required for the 2030 Agenda including distributed and multi-level governance Involve indigenous people in conservation management planning Design a plan that is not limited to the urban environment 	<ul style="list-style-type: none"> See "Coping with the increasing impacts of climate changes"
Enhancing social protection and environmental protection in developing countries as a means to decrease inequalities and combat environmental degradation and climate change.	<ul style="list-style-type: none"> Social and environmental protection 	<ul style="list-style-type: none"> Intensified climate pressure puts traditional solutions under pressure Social and economic pressure Risks of states abdicating Risks of damaging traditional forms of protection 	<ul style="list-style-type: none"> Social protection systems such as social insurance, sharing risk across social classes as well as across borders Innovation in economic mechanisms to finance support systems for protection Potential for new banking systems and financial methods to grow 	<ul style="list-style-type: none"> Climate change and globalization of the economy is requiring us to innovate in ways to deal with the issues 	<ul style="list-style-type: none"> Strengthening the social security net/social protection systems Build more resilient communities to absorb the shock as well as develop external protection mechanisms Adaptation strategies Development opportunities for new instruments that could provide a new social safety net 	<ul style="list-style-type: none"> Potential accumulation of global and national funds for social transfers from non-governmental sectors Global partnership: Political framework for national and global engagement Public inflows pressuring traditional social protection to become more vulnerable

Annex 6: (continued)

Emerging Issue	Value to be Sustained	Threats	Opportunities	Causal mechanisms	Responses/Actions	Key Emerging Features
Increasing the sustainability, inclusiveness, safety, and resilience of cities and human settlements.	<ul style="list-style-type: none"> • Inclusive, sustainable cities • Social inclusion • Multiculturalism/multilingualism in society 	<ul style="list-style-type: none"> • “Slumification” (sanitation, disease, water, multiple drug resistance, crime, etc.) • Negative social dynamics 	<ul style="list-style-type: none"> • Smart city: using science, technology, and data to provide services to the most vulnerable • Resource-efficient cities: leaders of the cities to be able to more efficiently use the resources (e.g. reduce energy consumption, transportation) 			<ul style="list-style-type: none"> • As the global population increases rapidly and resources decline, the resilience of cities is a key feature towards sustainable development

Source: Collective elaboration by contributing scientists for the GSDR 2016.

