

Perspective:

Connecting Climate Action with other Sustainable Development Goals

The international community has agreed to separate but interconnected commitments to combat climate change, and achieve 17 Sustainable Development Goals (SDGs) by 2030. Here we explore (dis)connections in evidence and governance between one set of commitments and the other. Our review of relevant evidence suggests that the impacts of climate change can undermine achievement of 16 SDGs, while action to address climate change can reinforce all 17 SDGs but also undermine efforts to achieve 12. Understanding of these relationships should be reinforced through interdisciplinary work between academic disciplines and evidence-synthesis initiatives. Governance processes and structures for climate change and other sustainable development challenges need to be better connected to maximize the legitimacy and effectiveness of action in both domains. The emergence around the world of coordinated institutions and planning for sustainable development is a promising step towards that end.

Francesco Fuso Nerini^{1*}, Benjamin Sovacool², Nick Hughes³, Laura Cozzi⁴, Ellie Cosgrave⁵, Mark Howells¹, Massimo Tavoni⁶, Julia Tomei³, Hisham Zerriffi⁷, Ben Milligan^{8}**

¹ Unit of Energy Systems Analysis (dESA), KTH Royal Institute of Technology, Brinellvägen 68, SE-100 44 Stockholm, Sweden.

² Science Policy Research Unit (SPRU), School of Business, Management, and Economics, Jubilee Building, University of Sussex, UK.

³ Institute for Sustainable Resources (ISR), University College London, 14 Upper Woburn Place, WC1H 0NN, London, UK.

⁴ World Energy Outlook team, International Energy Agency (IEA), 75015, 31-35 Rue de la Fédération, Paris, France.

⁵ Department of Science, Technology, Engineering and Public Policy (UCL STEaPP), University College London, 2nd Floor, Boston House, 36-38 Fitzroy Square, London W1T 6EY, UK.

⁶ Politecnico di Milano, Department of Management and Economics, and RFF-CMCC European Institute on Economics and the Environment (EIEE), Milano MI, Italy.

⁷ Department of Forest Resources Management, University of British Columbia Forest Sciences Centre, 2424 Main Mall, V6T 1Z4, Canada.

⁸ Faculty of Law, University of New South Wales, Anzac Parade, Kingsford NSW 2032, Australia.

* francesco.fusonerini@energy.kth.se, ** b.milligan@unsw.edu.au

Through the 2015 Paris Agreement on Climate Change, 197 countries have committed to ambitious efforts to combat climate change, adapt to its effects, and provide enhanced support to developing countries ¹. Alongside such commitments by national governments, endorsements of the Paris Agreement by companies, civil society and subnational governments have proliferated globally. In 2015 UN member countries also adopted the 2030 Agenda for Sustainable Development—a comprehensive global plan of action for “people, planet and prosperity” comprised of 17 Sustainable Development Goals (SDGs) and 169 Targets to be achieved by 2030 ², including Goal 13 on climate action.

These ambitious global commitments collectively mark the beginning of a new ‘post-2015’ era of sustainable development. They aspire for transformative change in a world confronted by grave social, economic, political and environmental challenges. They also require governance processes that cut across multiple sectors, stakeholders, and countries. Here we appraise the status of scientific evidence concerning relationships between one set of commitments and the other. We also highlight the urgent need for, and promising progress towards, better coordination between governance processes and structures for climate change, and other sustainable development challenges.

CLIMATE CHANGE ACTION AND THE SDGs

There is an ever-expanding body of evidence within specific domains focusing on how commitments of the Paris Agreement, and those of the 2030 Agenda, are interconnected with one another both normatively and empirically. This evidence indicates how impacts of climate change will make some development targets harder to achieve – for example the impacts of climate change on agricultural production which could set back efforts to reduce poverty and hunger^{3,4}. Actions taken to mitigate or adapt to climate change can also have direct interactions with development goals, involving both positive synergies and negative trade-offs^{5–10}. Analyses of diverse social, economic and country contexts have demonstrated how outcomes of climate action can have differential impacts on vulnerable social groups, including extreme cases where national climate adaptation programs have resulted in the violent displacement of poor communities¹¹.

While the links between climate change impacts, climate action and sustainable development are widely accepted, there has been limited structured investigation, at the level of specific SDG Targets, of synergies and trade-offs. The IPCC Special Report on Global Warming of 1.5°C¹² features a chapter that investigates links between certain climate mitigation and adaptation actions, and the 17 SDGs. While very useful, it does not assess specific synergies and trade-offs between climate impacts, climate action and all 169 individual Targets of the 2030 Agenda. Such assessment is essential to the holistic evaluation of climate-related policies, concerning mitigation and/or adaptation. The specificity of the SDG Targets enables detailed mapping of inter-relationships with and between them, to avoid trade-offs and maximize cross-sectoral policy synergies across domains^{13–15}. Target-level analyses of the SDGs have been called for^{13,14}, and completed for some several subject matters, both quantitatively and qualitatively. Quantitative analyses of interlinkages among SDGs Targets typically use indicator data on a set of Targets to understand statistical correlation, locally or globally (e.g.^{16–18}). Qualitative analyses (to which this Perspective contributes) typically use expert elicitation and surveys and look for published evidence of interlinkages among Targets. Past work includes mapping energy^{19,20}, water^{21,22}, ecosystem services²³, oceans²⁴, mining²⁵, and infrastructures²⁶ to the SDGs. However to date no such study has been undertaken for climate change impacts and climate action.

To address this gap, for each of the 169 Targets of the 2030 Agenda we analyzed a body of evidence addressing two intersecting questions: (A) Can the achievement of the Target be affected by climate change? and (B) Is there published evidence of synergies or trade-offs between the Target and climate action? Answers were developed using a consensus-based expert elicitation method. Building on Fuso Nerini et. al. 2017¹⁹, the expert elicitation process was undertaken by the authors as a body of experts from diverse disciplines spanning engineering, natural and social sciences. For question (B) we also assessed the relative strength of synergies and trade-offs using the scale proposed by Nilsson et al. (2016)^{14,27}, ranging from +3 (Indivisible) to -3 (Cancelling). The methodology and its limitations are reported in the Methods section.

In Figure 1 and 2 we summarize the results from our analysis (reported in greater detail in the supplementary material).

Climate change impacts on sustainable development

Our review highlights the pervasive implications of climate change across the diverse range of issues addressed by the SDGs. The identified evidence suggests it may severely exacerbate the already pronounced challenges of sustainable development. We find that action to achieve 67 Targets across 16 Goals could be undermined by climate change (Figure 1).

Figure 1 Impacts of climate change on the achievement of the SDGs. Each rectangle to the right of the relevant SDG logo in the diagram represents a Target. For Targets highlighted in light red, we found published evidence of impacts. The absence of highlighting indicates the absence of identified evidence, which does not necessarily mean absence of an impact.



Specifically, climate change will affect the achievability of goals relating to material and physical well-being such as prosperity and welfare, poverty eradication and employment, food, energy and water availability and health. For example: climate change impacts may exacerbate the distribution of disease vectors and disaster-related health risks²⁸ (Targets 3.3–3.4). Climate change-driven water shortages can directly impact health by reducing access to clean drinking water and sanitation²² (6.1–6.2, 6.4). Climate change may also impact the productivity of agricultural lands, causing malnutrition as well as loss of livelihoods and prosperity (1.1–1.5, 2.1–2.5, 8.1, 8.3–8.5, 12.1–12.2).

Climate change also undermines efforts to achieve justice and equality across the world. There is evidence that climate change hurts the poorest most, both within and between countries, exacerbating inequality and hampering poverty reduction (1.1–15, 10.1–10.2). Climate induced resource stresses - including on water, agricultural crops or other biotic resources - could exacerbate competition and conflict, threatening the peace and inclusivity of societies, and undermine social justice (12.1, 16.1). Climate change related impacts and disasters are also key drivers of human displacement and mass migrations (8.8, 10.7). Climate change can worsen gender inequalities, for example in cases where girls are the first to be withdrawn from schooling in response to drought or other climate-related shocks (4.1–4.2, 4.5). Climate-related disasters can lead to increased vulnerability of women and girls to violence, for example if they cause a shift in family power relations, or lead to women and girls being vulnerably housed (5.1–5.2). Women's unequal access to economic resources can also compound their vulnerability to climate impacts (5.4–5.5, 5.a–5.c).

Climate change poses a major stress for all ecosystems. For example, marine ecosystems face the threats of temperature change and ocean acidification (14.1–14.3, 14.7, 14.b) while terrestrial ecosystems may be profoundly altered through deglaciation of mountain systems, increased desertification, invasive species, habitat loss, and other climate-related factors (15.1–15.6, 15.8).

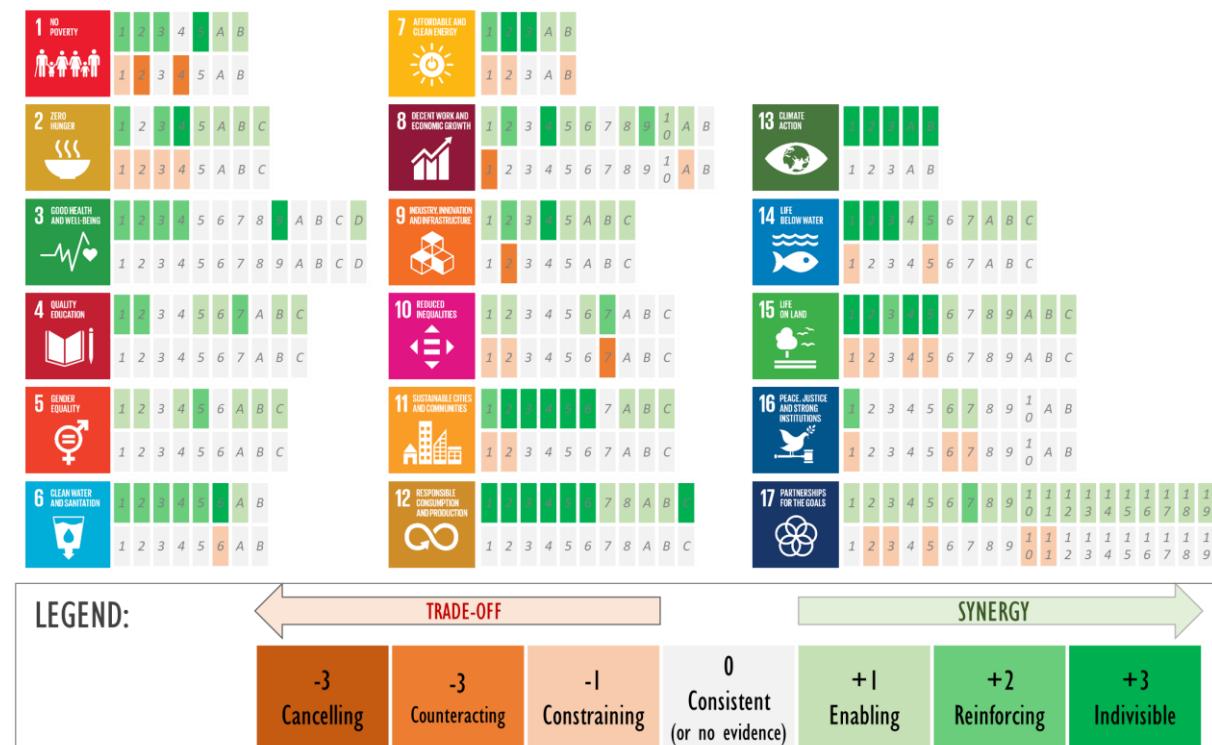
Finally, different levels of climate change will have different impacts across national and subnational contexts. A 1.5 degrees global warming trajectory could result in fewer people exposed to climate risks, reduced food and water insecurity, and reduced health impacts and economic losses when compared with a 2 degrees trajectory¹².

There is also evidence that climate change could have limited positive impacts, at least for some time, in certain areas of the world. For example, increased temperatures in temperate zones could support efforts to increase agricultural productivity (2.3). However, literature reports that these positive impacts are most likely to be experienced by currently high income countries, thereby increasing inequality between high and low income countries²⁹.

Sustainable development and climate action

It is of great concern that climate change might impact almost all aspects of sustainable development, giving rise to a pressing need to understand how action to address climate change can reinforce or undermine all other SDGs, and vice versa. Our analysis identifies evidence of synergies between climate action and 134 Targets across all SDGs (Figure 2).

Figure 2 Synergies and trade-offs between climate action and the SDGs. Each rectangle to the right of the relevant the SDG logo in the diagram represents a Target. The highlighting represents the strength of an interaction (scale in legend at the bottom of the image adapted from Nilsson et al, (2016, 2018)^{14,27} and explained in detail in the methods). The absence of highlighting indicates the absence of identified evidence. Absence of identified evidence does not necessarily imply the absence of an interlinkage.



For example, climate action can enable and reinforce building prosperous, equal and peaceful societies. It provides a foundation for building strong, functioning and capable institutions (Targets 17.1–17.19), and has synergies with Targets concerning poverty reduction, welfare and jobs Targets (1.1–1.2, 1.4–1.a, 8.1–8.2, 8.4–8.5, 8.8–8.9, 8.1). The north-to-south and the south-to-south mechanisms embedded in climate action are consistent with commitments to both ‘contract and converge’ emissions and ‘level the playing field’ across countries, decreasing inequalities among and within countries (10.1–10.2, 10.7, 14.7, 15.6).

Climate action will require efforts to better plan and manage resources in an integrated way. Many of the Targets on food- (2.1- 2.b) water- (6.1–6.a) and energy- (7.2–7.3) systems are reinforcing or indivisible with climate action. Progress on several Targets concerning sustainable consumption and production (12.1-12.6) will advance climate action by reducing emissions related to wastes and production. Climate action is also indivisible from the achievement of several environmental and health Targets. We found synergies between climate action and the management and conservation of other environmental resources, such as marine (14.1–14.5) and terrestrial (15.1–15.5, 15.8–15.9) ecosystems. Climate action can improve global health outcomes (3.3–3.4, 3.9) by reducing local pollution in households and cities, that harm billions of people every day³⁰. Finally, evidence shows sustainable cities and human settlements (11.1-11.6) will have to play a key role in both climate mitigation and adaptation efforts.

Notably, there are approximately four times fewer trade-offs than synergies between climate action and the delivery of the SDGs (34 Targets across 12 Goals). Those trade-offs nevertheless have the potential

to block climate action—or conversely other development gains—for two broad reasons: First, climate mitigation policies can be costly in the short term in macro-economic terms, especially for carbon intensive and energy exporting regions (8.1)¹², and could impair carbon intensive activity and industries (9.2) (while boosting others). In the energy sector alone, it is estimated that investing USD3.5 trillion each year between 2016 and 2050, will be needed to stay on a 1.5 degrees trajectory³¹. Climate action could also adversely affect millions of workers globally and their communities working in the fossil fuel industries absent a “Just Transition” plan. Second, climate policies, if not properly designed can be socially and economically regressive, exacerbating inequality and poverty (1.1–1.2). For instance, certain climate policies can impact land and food prices (1.4, 2.3–2.4) increasing the risk of leaving behind small agricultural holders (2.3–2.4). Some national climate adaptation programs have even resulted in violence, conflict, and death¹¹. In the energy sector, while climate action would underpin the adoption of efficient and renewable energy (7.2–7.3) it might affect the delivery of affordable, reliable and modern energy services for all by 2030 (7.1)—as fossil fueled energy can be cheaper in certain energy poor areas³².

Such issues may pose difficult choices for decision makers, which cannot be resolved simplistically and require careful consideration¹³. Navigating the complex interactions between climate change and sustainable development requires rethinking both how scientific evidence is generated, and how governance and politics operate across sectors.

Finally, it is worthwhile to recall that the Targets under each SDG are divided into number-designated outcome Targets, and letter-designated Means of Implementation (MoI) targets – as shown in Figure 2. In considering alignment with climate action, it is relevant to focus on the MoI Targets, and to appreciate that 15 out of 17 SDGs have one or more MoI Targets which enable (+1) or reinforce (+2) climate action (and vice-versa) - while only 2 SDGs include MoI targets that have direct trade-offs with climate action. This result indicates a particular alignment of the implementation actions for the SDGs, with climate action.

CONNECTING THE SCIENCES

Knowledge and evidence concerning relationships between sustainable development and climate action are scattered across many different institutions, locations, and across disciplines – both at the global and local scale. This fragmentation represents a critical barrier to a holistic and integrated understanding of the social-environmental systems embodied in the SDGs³³. Understanding the potential impacts of climate change on all sustainable development domains is crucial to raise awareness and policy support for climate action, and for planning adaptation programs that minimize climate change impacts and maximize progress across all SDGs. The current structure and practice of research simply does not do justice to these connections in at least three ways, each of which we now explore and suggest solutions.

First, ‘climate–development’ research requires mutually respectful methodological integration across natural sciences, engineering and social sciences/humanities in order both to understand the complex social-ecological dynamics at play, and to develop solutions that are based on a sound understanding of both physical and social systems. Advantages of such interdisciplinary approaches to science include enhanced legitimacy, the ability to attract and retain cutting-edge scientists and students, delivery of useful knowledge to society and enriching of research³⁴. However, institutionally such post-disciplinary work can be difficult to justify to funders focused on narrow academic fields, who assess research excellence and risk accordingly. Some communities are also dismissive of others and perpetuate “disciplinary chauvinism”³⁵. To remedy this situation, funding agencies and research institutions could be further encouraged and incentivized to support research across disciplines, spanning the full range of physical sciences, engineering, social sciences and arts and humanities. Funding agencies could for example require applicants to specify how proposals link to specific SDGs. Such an approach, being pioneered by the likes of The Swedish Research Council Formas and UK Global Challenges Research Fund, allows stakeholders to organize projects into SDG-thematic areas, and facilitates linking research outputs across disciplines. Effort should also be dedicated to the monitoring of how funded projects enable practical progress towards sustainable development³⁶ and on strengthening the science-policy interface³⁷.

Second, research on specific topic domains is often siloed and relatively little research is done across them. At the macro-level, climate change mitigation, climate change adaptation and sustainable development are commonly characterized as distinct fields, despite their inextricable interconnections. At the micro-level, topics such as water, energy, mobility and transport, food, land use, biodiversity, etc. are starting to be treated through integrative ‘nexus’ approaches but these do not yet predominate. More efforts are needed to develop practical frameworks for exploring interlinkages among SDGs, giving also attention to overlooked drivers and regions^{38,39}. Limited literature has systematically evaluated context specific synergies and trade-offs between climate action and the SDGs¹². Addressing this challenge further will require diverse knowledge communities (including custodians of traditional or ‘non-expert’ knowledge) to gather to tackle the world’s most pressing sustainable development challenges in a coherent and synergistic manner. It is important in this context to acknowledge and address deeply ingrained cultures and norms that prevent the fruitful exchange of information and ideas. The growing body of research on the interconnections among disciplines in the context of the SDGs is encouraging, but remains confined to relatively few research teams. Our mapping exercise could also be used as a starting point to identify interlinkages where little or no published evidence is available. Large research organizations should dedicate some effort to identifying how their focal research areas interact and promote collaboration across disciplinary teams. These could be guided by pioneering activities such as those for mapping research contributions in universities to the SDGs⁴⁰.

Moreover, addressing both the breadth and depth of the knowledge necessary to progress the SDGs will be necessary. Meta-analyses could be used to gather studies across many disciplines (breadth) to highlight areas where more focused research is needed (depth)⁴¹. For that to happen inter-disciplinary programs and collaborations will be needed to build upon the deep understanding of participants in their field while bringing data and expertise together to provide breadth. The SDSN networks⁴² are a promising example of this, bringing together research institutions from across the world. Inclusion of interactional expertise will also be necessary to encourage greater feedback and integration of diverse viewpoints⁴³, collecting knowledge from non-traditional actors such as laypersons, indigenous groups and community leaders.

Third, the global institutional framework for evidence assessment and synthesis is fragmented, with insufficient attention paid to connecting efforts across distinct but substantively non-discrete institutional mandates. Remedyng this situation is challenging. The sheer scope of the remit of an evidence synthesis body such as the IPCC, to take one example, is vast, with three working groups covering the physical science of the climate system, impacts, and mitigation. With such expertise in depth across such a wide area, a straightforward call for the Panel itself to achieve even greater breadth, in order better to address cross-cutting issues, might be seen to test the limits of practicability to breaking point. Nonetheless, the Panel’s explorations of impacts and dynamics in, for example, land, oceans and biodiversity, bring clear overlaps with activities of other existing organizations such as the International Land Coalition, the International Oceanographic Commission, the International Resource Panel and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Thus, the key question is less how to make any individual existing body broader in scope, but rather how existing in-depth expertise marshalled by various expert evidence synthesis organizations can be leveraged and combined in a way that also enables the crosscutting nature of the SDG challenges to be addressed.

International institutions tasked with evidence assessment and synthesis should devote some effort to organizing their work in terms of specific SDGs and Targets, building as appropriate on the recent work of the IPCC¹² and the UN International Resource Panel⁴⁴, while leveraging the existing knowledge of other initiatives such as the Campbell Collaboration⁴⁵ and the Global Evidence Synthesis Initiative (GESI)⁴⁶. The design of the assessment activities themselves can also help by embedding crosscutting themes within the guiding research questions that are used to structure research synthesis. An approach of this kind has been demonstrated by the UN’s Global Sustainable Development Report (GSDR)⁴⁷. Rather than addressing the SDGs sequentially, the report instead proposes crosscutting themes or questions as the basis for moving between SDGs and identifying links between them. For example, the 2016 GSDR⁴⁷ ‘examines interlinkages between infrastructure, inequality and resilience’. Similarly, the report also takes a crosscutting view on the role of technology in delivering the SDGs. In this way the

structure of the research design used in the GSDR naturally brings out cross-SDG linkages, and therefore could offer a potential template for scaling up. The IPBES Assessment Report on Land Degradation and Restoration⁴⁸. This report identifies a theme and uses the SDGs as a structuring device to identify important synergies. Building on these examples, regular programs of joint meetings between different evidence synthesis and assessment should be considered, alongside the possibility of coordinated action through co-development of workshops, reports, and media events focused on connecting of evidence concerning climate change and sustainable development.

CONNECTING GOVERNANCE

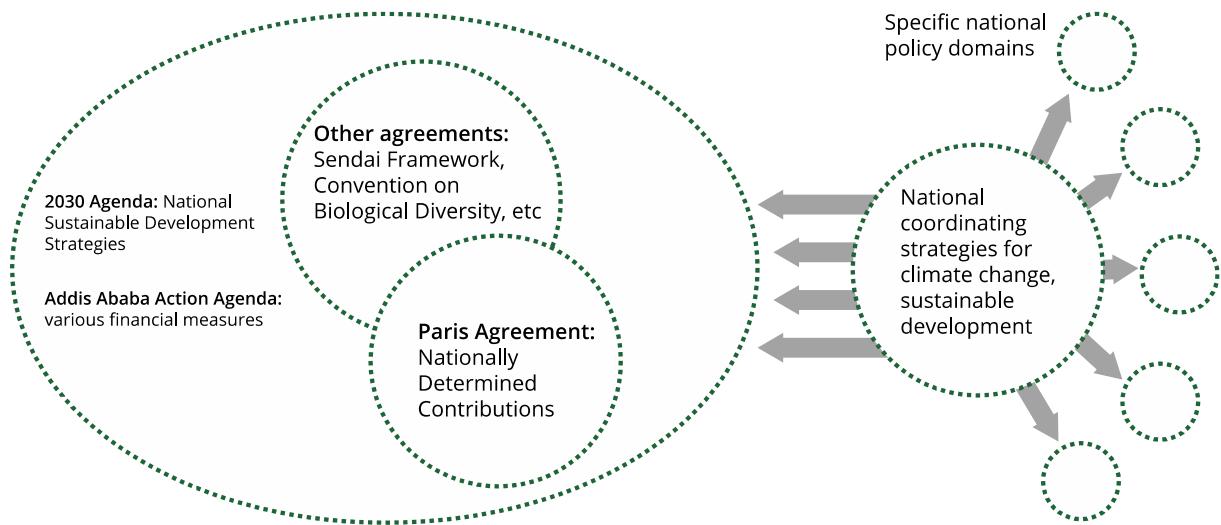
Frictions between climate action and broader sustainable development policy can undermine social and political support in both domains, whereas capitalizing on synergistic actions can enable both sets of objectives to be met more quickly, efficiently and effectively. For these reasons, several calls have been made for policymaking on climate action and sustainable development to act more holistically across multiple agendas^{6,8,12,49}.

Both nationally and internationally, many decisions about climate change and sustainable development remain isolated within their respective silos. For example, while all of the 173 Nationally Determined Contributions have impacts on the achievement of selected SDGs⁵⁰ both globally and regionally⁵¹, to date only 22 explicitly mention the SDGs, and none of them discuss in detail the impact of climate policy on the achievement of the SDGs. NDCs published by only two governments (Palestine and Tunisia) discuss at a general level the possible impacts of the NDCs on sustainable development.

The interrelationships shown in Figure 1 and Figure 2 highlight the shortcomings of this prevailing approach to governance. The widespread potential impacts of climate change—spanning 16 SDGs and ~40% of the targets—challenge conventional modes of governance, presenting a powerful case for harmonization of climate action with policies, plans and strategies for social and economic development. It is encouraging in this context that we have identified evidence of synergies between climate action and ~80% of Targets in the 2030 Agenda. This underscores the opportunities that can be seized by identifying, and marshalling resources behind climate actions that have been shown to have a wider ‘development-dividend’. While the trade-offs between climate action and other sustainable development targets are fewer in number (~20% of Targets), knowledge of the distributional impacts of climate action is crucial to design holistic policies in which no-one is left behind.

Harmonizing climate action with broader Sustainable Development Goals will require considerable reform to the policy and governance structures in both domains. Internationally, there is a need for new linking strategies and deliberations—for example at the UN Climate Change Conferences, and the High-Level Political Forums on Sustainable Development—that empower countries and other stakeholders to implement relevant climate change and sustainable development commitments in a coherent and mutually reinforcing manner. In addition to the range of commitments recognized in the Paris Agreement and 2030 Agenda, these also include the Addis Ababa Action Agenda on Finance for Sustainable Development, Sendai Framework for Disaster Risk Reduction, Convention on Biological Diversity and other multilateral agreements concerning the environment. As Figure 3 illustrates, each of these commitments entails national implementation and reporting processes, which should be connected together in governance processes as an interlocking whole.

Figure 3 Process links between international commitments on climate change and sustainable development. Circles represent the overlapping subject matter scope of each set of commitments — for example the scope of the 2030 Agenda includes climate change (SDG13) which is the principal focus of the 2015 Paris Agreement.



Within countries, there is an urgent need to develop ambitious and coordinated policy frameworks for climate change and sustainable development. Consistent leadership in both domains could be supported by (1) stronger coordination between the lead institutions (often separate ministries with their own topical jurisdictions) responsible for development and climate policy, (2) having either the institution responsible for the SDGs or climate action leading the coordination of the two agendas or (3) designation of a single institution responsible for the leadership of both the SDGs and climate action⁵². Efforts like the NDC Partnership—a coalition of countries and institutions working to advancing the NDC in synergy with the SDGs—will be crucial for promoting such coordination and sharing best practices.

A key step therefore will be to ensure that institutional frameworks within governments are designed to coordinate working across SDG areas. The OECD recommends ‘dismantling intellectual and policy silos’ and ‘enhancing policy and institutional coherence by identifying policy interactions, trade-offs and synergies across economic, social and environmental areas’⁵³. Institutional arrangements that encourage the joining up of potentially siloed ministries or portfolios are key to successful implementation at the national level. In some cases, countries have created new institutions and frameworks specifically for the implementation of the 2030 Agenda. In Colombia, an important institutional innovation was the establishment of a High-Level Inter-Agency Commission for the Preparation and Effective Implementation of the Post-2015 Development Agenda⁵⁴. The cross-departmental constitution of this commission may prove useful in helping to improve a cross-sectoral approach to the SDGs.

In other cases, existing institutions, frameworks and tools may be usefully adopted as part of the Agenda 2030 strategy. For example, in Mexico the National Council for the Evaluation of Social Development Policy (CONEVAL) has developed a multi-dimensional poverty measure, which has been used since 2012 ‘to target and coordinate multi-dimensional, inter-agency and inter-government (federal, state, municipal) social development strategy’⁵⁵. The multi-dimensional nature of this measure makes it well suited for addressing SDG 1 in a way that accounts for synergies with other goals, including hunger, health and wellbeing, education, water and sanitation, affordable and clean energy, reduced inequalities and sustainable cities and communities. Comparable multi-dimensional tools for measuring progress on SDG 13 would be similarly helpful in tracing the interdependencies and identifying the synergies between climate action and the other goals.

There are also promising examples of connected national governance within strategies and proposals of nation states. In Canada’s Federal Sustainable Development Strategy⁵⁶, the 13 goals of the strategy are connected with relevant SDGs and Targets. The final report of the Swedish Delegation for the 2030 Agenda⁵⁷ presents a number of recommendations to help meet the Agenda Targets, including around

governance processes, enhancing opportunities at regional levels and enabling the participation of all actors. South Korea's Third Basic Plan for Sustainable Development⁵⁸ is described as a 'basic platform to implement the Agenda 2030'. It comprises 14 'strategic targets' within four 'overarching goal areas', namely 'healthy land', 'integrated and safe society', 'inclusive creative economy' and 'global responsibility'. South Korea has a number of other Plans which correspond to other SDGs. A similar approach was taken in Indonesia⁵⁹ where an SDG Transition Secretariat was established, which sorted the SDGs, Targets and indicators into four areas: social, economic, environment, and law and governance, before mapping the SDGs against the government's National Medium-Term Development Plan (RPJMN). The above mentioned efforts present plans to achieve several SDGs holistically, however they are still limited in identifying and leveraging on synergies and trade-offs among SDGs Targets.

To connect climate action with broader sustainable development, NDCs (and more broadly national climate policy) could explicitly include assessments of the synergies and trade-offs with broader sustainable development. Similarly, donor agencies could assess the sustainability of particular climate action interventions. Such assessments should be undertaken at a granular level using the detail provided by the SDG Targets. Although a political compromise, the SDGs provide a powerful lens through which people and institutions can test the potential outcomes of their decisions across a wide range of objectives that have gained political acceptance at a global level. Clear guidelines on how to connect climate action and sustainable development will be needed. The IPCC, academics and other stakeholders could build on current progress to work together to develop a framework gathering such guidelines. This could also build on previous efforts in tracking SDGs progress⁶⁰ and setting priorities among SDGs both with qualitative⁶¹ and quantitative^{7,62,63} methods. Further, the recurring COP meetings provide an opportunity for the international community to discuss how to make commitments to coherent and convergent implementation of the Paris Agreement, 2030 Agenda, and other post-2015 commitments.

Connecting climate change and other sustainable development governance structures is vital to avoid detrimental trade-offs in either direction, but it also presents a compelling and considerable opportunity for mutually enhancing outcomes to deliver a better world by 2030 and beyond.

METHODS

For each of the 169 Targets of the 2030 Agenda we analyzed a body of evidence addressing two intersecting questions: (A) Can the achievement of the Target be affected by climate change? and (B) Is there published evidence of synergies or trade-offs between the Target and climate action? Answers were developed using a consensus-based expert elicitation method. Building on Fuso Nerini et. al. 2017¹⁹, the expert elicitation process was undertaken by the authors as a body of experts from diverse disciplines spanning engineering, natural and social sciences. For question (B) the strength of the interlinkages was captured using an adaptation of the taxonomy developed by Nilsson et al. (2016, 2018)^{14,27}, which proposes a 7-point scale for assessing the strength of the interlinkages among SDGs, from +3 (Indivisible) to -3 (Cancelling) (Table 1). Our review of evidence suggests that there are multiple context-specific synergies and trade-offs within each Target. Therefore, a range interaction score was given for each Target. For instance, Target 11.2 (*By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons*) could have an interaction score ranging from -1 to +3, depending on how it is implemented at the local level. -1 as climate action constrains the options to deliver the Target (that should have lower emissions or be more adaptive than the existing ones). +1 to +3 to the extent that safe and sustainable (and public) transport improves climate mitigation and adaptation outcomes.

Table 1 Used taxonomy for quantifying the strength of the interactions between climate action and all 169 Targets of the 2030 Agenda for Sustainable Development. Adapted for the purpose of this Perspective from Nilsson et al. (2016, 2018)^{14,27}

INTERACTION SCORE	EXPLANATION
+3 Indivisible	Progress on climate action automatically delivers progress on the Target AND/OR Progress on the Target automatically delivers progress on climate action
+2 Reinforcing	Progress on climate action makes it easier to make progress on the Target AND/OR Progress on the Target makes it easier to make progress on climate action
+1 Enabling	Progress on climate action creates conditions that enable progress on the Target AND/OR Progress on the Target creates conditions that enable progress climate action
0 Consistent (or no evidence found)	The authors found no published evidence of a significant interlinkage between climate action and the Target achievement. Absence of identified evidence could mean that the two are consistent and does not necessarily mean that there is absence of an interlinkage. It could also mean that there is lack of published literature on the interlinkage, or that the authors could not find already published material on the interlinkage.
-1 Constraining	Progress on climate action constrains the options for how to deliver the Target AND/OR Progress on the Target constrains the options for how to deliver climate action
-2 Counteracting	Progress on climate action makes it more difficult to make progress on the Target AND/OR Progress on the Target makes it more difficult to make progress on climate action
-3 Cancelling	Progress on climate action automatically leads to a negative impact on the Target AND/OR Progress on the Target automatically leads to a negative impact on climate action

The design of the expert elicitation process was explicitly informed by Butler et al. (2015) and Morgan (2014)^{64,65}. The process involved the expert-driven search for published studies in academic and peer-reviewed ‘grey literature’ (e.g. reports published by international organizations). Group members did not undertake a systematic review of evidence relevant to each Target. Instead, a single item of relevant published evidence was deemed sufficient to indicate an impact of climate change (for A) or synergies/trade-offs with climate action. Nevertheless, for nearly all Targets with interlinkages several items of published evidence were found. All found evidence is reported in the supplementary material. The strength of the interlinkages for question (B) (Table 1) was assessed based on the content of the identified evidence, the wording of the Target (e.g. for Targets with interlinkages existing ‘by definition’ of the target), and on the expertise of the authoring team. For question B, climate action was defined as the general set of mitigation, adaptation, and related finance and capacity building actions referred to in the Paris Agreement, which are also acknowledged in Goal 13 of the 2030 Agenda. This definition encompasses but does not distinguish all of the detailed actions specified in countries’ Nationally Determined Contributions (NDCs) under the Paris Agreement.

A structured review process was adopted to reach a consensus on the results for questions A and B for all 169 Targets. For each Target, the answer for questions A and B was first assessed by one of the authors, allocated depending on her/his area of expertise. Then, each Target was reviewed (and enriched) by three other authors. Finally, during group meetings, results for questions A and B were refined through facilitated discussion until a consensus was reached. Results for all 169 Targets were reviewed systematically and inductively coded to reach a consensus view among the authoring team.

While the authoring team have a wide topical and geographical expertise (spanning engineering, natural and social sciences and with published research covering all continents), it is reasonable to believe that several interlinkages between climate change, action and the SDGs were not captured in this Perspective. For instance, some existing literature on specific interlinkages might not have been found by the authors. For other existing interlinkages there might not be published evidence yet. Therefore, the absence of identified literature does not necessarily mean the absence of an interlinkage. However, the interlinkages captured in this Perspective are based on existing published literature, and are therefore verifiable and replicable. The interlinkages then provide recommendations that represent the *Perspective* of the authors. Future studies could use this study as a starting point to add interlinkages or evidence to the analysis, and to have an initial body of literature to identify possible interlinkages for local level studies.

References

1. United Nations. *Paris Agreement on Climate Change*. (2015).
2. UN General Assembly (UNGA). Transforming our world: the 2030 Agenda for Sustainable Development. *Resolut. A/RES/70/1*, 25 1–35 (2015).
3. Wheeler, T. & von Braun, J. Climate change impacts on global food security. *Science* **341**, 508–13 (2013).
4. Smith, M. R. & Myers, S. S. Impact of anthropogenic CO₂ emissions on global human nutrition. *Nat. Clim. Chang.* **8**, 834–839 (2018).
5. Thornton, T. F. & Comberti, C. Synergies and trade-offs between adaptation, mitigation and development. *Clim. Change* **140**, 5–18 (2017).
6. Favretto, N., Dougill, A., Stringer, L., Afionis, S. & Quinn, C. Links between Climate Change Mitigation, Adaptation and Development in Land Policy and Ecosystem Restoration Projects: Lessons from South Africa. *Sustainability* **10**, 779 (2018).
7. Obersteiner, M. *et al.* Assessing the land resource-food price nexus of the Sustainable Development Goals. *Sci. Adv.* **2**, e1501499–e1501499 (2016).
8. Scobie, M. Policy coherence in climate governance in Caribbean Small Island Developing States. *Environ. Sci. Policy* **58**, 16–28 (2016).
9. Riahi, K. *et al.* The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Glob. Environ. Chang.* **42**, 153–168 (2017).
10. Jewell, J. *et al.* Comparison and interactions between the long-term pursuit of energy independence and climate policies. *Nat. Energy* **1**, 16073 (2016).
11. Sovacool, B. K. Bamboo Beating Bandits: Conflict, Inequality, and Vulnerability in the Political Ecology of Climate Change Adaptation in Bangladesh. *World Dev.* **102**, 183–194 (2018).
12. IPCC. *Global Warming of 1.5 C*. (2018).
13. Fuso Nerini, F. *et al.* Use SDGs to guide climate action. *Nature* **557**, (2018).
14. Nilsson, M., Griggs, D. & Visbeck, M. Map the interactions between Sustainable Development Goals. *Nature* **534**, 320–322 (2016).
15. McGowan, P. J. K., Stewart, G. B., Long, G. & Grainger, M. J. An imperfect vision of indivisibility in the Sustainable Development Goals. *Nat. Sustain.* **2**, 43–45 (2019).
16. Lusseau, D. & Mancini, F. Income-based variation in Sustainable Development Goal interaction networks. *Nat. Sustain.* **2**, 242–247 (2019).
17. Pradhan, P., Costa, L., Rybski, D., Lucht, W. & Kropp, J. P. A Systematic Study of Sustainable Development Goal (SDG) Interactions. *Earth's Futur.* **5**, 1169–1179 (2017).

18. Rosenthal, J., Quinn, A., Grieshop, A. P., Pillarisetti, A. & Glass, R. I. Clean cooking and the SDGs: Integrated analytical approaches to guide energy interventions for health and environment goals. *Energy Sustain. Dev.* **42**, 152–159 (2018).
19. Fuso Nerini, F. *et al.* Mapping synergies and trade-offs between energy and the Sustainable Development Goals. *Nat. Energy* **3**, 10–15 (2017).
20. McCollum, D. L. *et al.* Connecting the sustainable development goals by their energy inter-linkages. *Environ. Res. Lett.* **13**, 033006 (2018).
21. Velis, M., Conti, K. I. & Biermann, F. Groundwater and human development: synergies and trade-offs within the context of the sustainable development goals. *Sustain. Sci.* **12**, 1007–1017 (2017).
22. UN Water. *Water and Sanitation Interlinkages across the 2030 Agenda for Sustainable Development.* (2016).
23. Wood, S. L. R. *et al.* Distilling the role of ecosystem services in the Sustainable Development Goals. *Ecosyst. Serv.* **29**, 70–82 (2018).
24. Singh, G. G. *et al.* A rapid assessment of co-benefits and trade-offs among Sustainable Development Goals. *Mar. Policy* (2017). doi:10.1016/J.MARPOL.2017.05.030
25. United Nations. Mapping Mining to the Sustainable Development Goals: An Atlas. **77** (2016).
26. Thacker, S. *et al.* Infrastructure for sustainable development. *Nat. Sustain.* **2**, 324–331 (2019).
27. Nilsson, M. *et al.* Mapping interactions between the sustainable development goals: lessons learned and ways forward. *Sustain. Sci.* **13**, 1489–1503 (2018).
28. Watts, N. *et al.* The Lancet Countdown on health and climate change: from 25 years of inaction to a global transformation for public health. *Lancet (London, England)* **391**, 581–630 (2018).
29. IPCC. *IPCC Fifth Assessment Report.* (2014).
30. Watson, J. & Morgan Jones, M. What are the major barriers to increased use of modern energy services among the world's poorest people and are interventions to overcome these effective? *CEE Rev.* **11-004** 1–91 (2011).
31. IEA & IRENA. *Perspectives for the Energy Transition. Investment Needs for a Low-Carbon Energy System.* (2017).
32. Nerini, F. F. *et al.* A cost comparison of technology approaches for improving access to electricity services. *Energy* (2016). doi:10.1016/j.energy.2015.11.068
33. Game, E. T. *et al.* Cross-discipline evidence principles for sustainability policy. *Nat. Sustain.* **1**, 452–454 (2018).
34. Lubchenco, J., Barner, A. K., Cerny-Chipman, E. B. & Reimer, J. N. Sustainability rooted in science. *Nat. Geosci.* **8**, 741–745 (2015).
35. Sovacool, B. K. *et al.* Integrating social science in energy research. *Energy Res. Soc. Sci.* **6**, 95–99 (2015).
36. Persson, Å. *et al.* *Forskning för Agenda 2030 Översikt av forskningsbehov och vägar framåt.* (2018).
37. Koontz, T. M. & Thomas, C. W. Use of science in collaborative environmental management: Evidence from local watershed partnerships in the Puget Sound. *Environ. Sci. Policy* **88**, 17–23 (2018).
38. Liu, J. *et al.* Nexus approaches to global sustainable development. *Nat. Sustain.* **1**, 466–476 (2018).
39. Howells, M. *et al.* Integrated analysis of climate change, land-use, energy and water strategies. *Nat. Clim. Chang.* **3**, 621–626 (2013).

40. Körfgen, A. *et al.* It's a Hit! Mapping Austrian Research Contributions to the Sustainable Development Goals. *Sustainability* **10**, 3295 (2018).
41. Gurevitch, J., Koricheva, J., Nakagawa, S. & Stewart, G. Meta-analysis and the science of research synthesis. *Nature* **555**, 175–182 (2018).
42. SDSN. SDSN Networks Program. Available at: <https://networks.unsdsn.org/>. (Accessed: 12th April 2019)
43. Gorman, M. E. *Trading zones and interactional expertise : creating new kinds of collaboration.* (MIT Press, 2010).
44. International Resource Panel. *Policy Coherence of the Sustainable Development Goals.* (2017).
45. The Campbell Collaboration. The Campbell Systematic Reviews. Available at: <https://campbellcollaboration.org/library>. (Accessed: 12th April 2019)
46. Cochrane Effective Practice and Organisation of Care. Global Evidence Synthesis Initiative – GESI. Available at: <https://epoc.cochrane.org/news/gesi>. (Accessed: 12th April 2019)
47. United Nations. *GLOBAL SUSTAINABLE DEVELOPMENT REPORT.* (2016).
48. Leeprakton LI, T. P. *et al.* *THE ASSESSMENT REPORT ON LAND DEGRADATION AND RESTORATION. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* (2018).
49. Nhamo, L. *et al.* The Water-Energy-Food Nexus: Climate Risks and Opportunities in Southern Africa. *Water* **10**, 567 (2018).
50. DIE, German Development Institute & SEI. NDC-SDG Connections: Bridging climate and the 2030 Agenda. Available at: <https://klimalog.die-gdi.de/ndc-sdg/>. (Accessed: 30th August 2018)
51. Iyer, G. *et al.* Implications of sustainable development considerations for comparability across nationally determined contributions. *Nat. Clim. Chang.* **8**, 124–129 (2018).
52. GIZ & WRI. *Connecting the Dots: Elements for a Joined-Up Implementation of the 2030 Agenda and Paris Agreement. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)* (2018).
53. OECD. *Better Policies for 2030 An OECD Action Plan on the Sustainable Development Goals.* (2016).
54. Pineda-Escobar, M. A. Moving the 2030 agenda forward: SDG implementation in Colombia. *Corp. Gov. Int. J. Bus. Soc.* **19**, 176–188 (2019).
55. Scott, J. *Implementing the 2030 Agenda in Mexico.* (2018).
56. Gouvernement of Canada. *Achieving a sustainable future, draft federal sustainable development strategy for Canada 2019 to 2022: closed consultation - Canada.ca.* (2019).
57. Government Offices of Sweden. *Reference: Swedish Delegation for the 2030 Agenda (2019) The 2030 Agenda and Sweden – a Summary.* (2019).
58. The Government of the Republic of Korea. *Year One of Implementing the SDGs in the Republic of Korea: From a Model of Development Success to a Vision for Sustainable Development 2016 National Voluntary Review.* (2016).
59. Bastos Lima, M. G., Kissinger, G., Visseren-Hamakers, I. J., Braña-Varela, J. & Gupta, A. The Sustainable Development Goals and REDD+: assessing institutional interactions and the pursuit of synergies. *Int. Environ. Agreements Polit. Law Econ.* **17**, 589–606 (2017).
60. Schmidt-Traub, G., Kroll, C., Teksoz, K., Durand-Delacre, D. & Sachs, J. D. National baselines for the Sustainable Development Goals assessed in the SDG Index and Dashboards. *Nat. Geosci.* **10**, 547–555 (2017).
61. Weitz, N., Carlsen, H., Nilsson, M. & Skånberg, K. Towards systemic and contextual priority

- setting for implementing the 2030 Agenda. *Sustain. Sci.* 1–18 (2017). doi:10.1007/s11625-017-0470-0
- 62. O'Neill, D. W., Fanning, A. L., Lamb, W. F. & Steinberger, J. K. A good life for all within planetary boundaries. *Nat. Sustain.* **1**, 88–95 (2018).
 - 63. McCollum, D. L. *et al.* Energy investment needs for fulfilling the Paris Agreement and achieving the Sustainable Development Goals. *Nat. Energy* **3**, 589–599 (2018).
 - 64. Butler, A. J., Thomas, M. K. & Pintar, K. D. M. Systematic Review of Expert Elicitation Methods as a Tool for Source Attribution of Enteric Illness. *Foodborne Pathog. Dis.* **12**, 367–382 (2015).
 - 65. Morgan, M. G. Use (and abuse) of expert elicitation in support of decision making for public policy. *Proc. Natl. Acad. Sci. U. S. A.* **111**, 7176–84 (2014).