SEI Stockholm Environment Institute

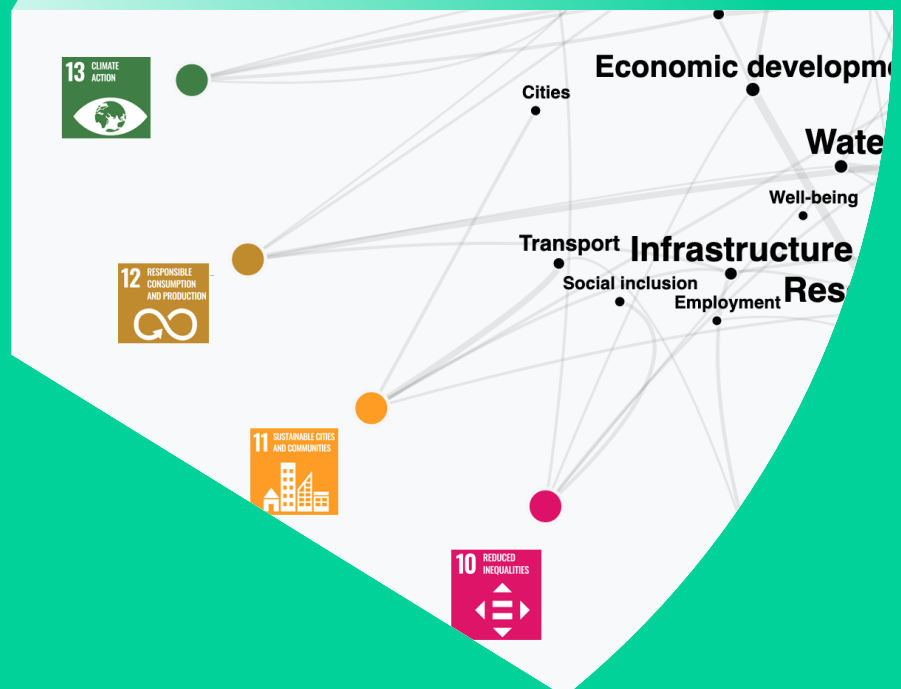# Sustainable Development Goal interactions through a climate lens: a global analysis

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organization that tackles environment and development challenges.
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Summary

Since the adoption of the 2030 Agenda and the Paris Agreement in 2015, researchers and practitioners have emphasized the need for policy coherence in implementing both together, to ensure that progress can be made on climate and development goals concurrently. To date, however, much of the research on Sustainable Development Goal (SDG) interactions has focused instead on identifying synergies and trade-offs among specific SDG sectors or geographic locations, and not across the two agendas globally.

We aim to fill this gap by providing a global-level analysis of how adding a boundary condition of a 1.5°C climate target impacts synergies and trade-offs among specific SDG targets. Utilizing a cross-impact matrix based on experts' perceptions, we provide a global picture of whether progress on key development goals can be made while reducing emissions. We also identify SDG targets that conflict with each other when being implemented in a context that requires a reduction in climate-changing emissions.

Overall, however, we find that interactions between key SDG targets are synergetic at the global level when pursuing efforts to limit the temperature increase to 1.5°C. Our findings indicate two objectives are most beneficial for making progress on all other targets: making progress on mobilizing climate finance and Official Development Assistance (ODA) and mainstreaming climate change into national policy.

In addition, our findings show that broad achievement of the SDG targets in tandem with staying within 1.5°C of warming would have a strong positive influence on reducing inequality, vulnerability and poverty while increasing resilience and adaptive capacity globally. While the implication of our findings is that there are strong synergies between the 2030 Agenda and the Paris Agreement, more research is necessary to explore how these synergies are enforced in practice and whether trade-offs and goal conflicts manifest in different forms.

1. Introduction

Climate change and sustainable development pose significant intertwined challenges. In 2015, the adoption of the UN Framework Convention on Climate Change (UNFCCC) Paris Agreement and the 2030 Agenda and its 17 Sustainable Development Goals (SDGs) represented major progress for multilateral efforts to address the world's most pressing problems. The single biggest challenge to achieving sustainable development remains taking urgent action to combat climate change and its impacts. A growing body of evidence demonstrates that climate action necessitates a transition that addresses all dimensions of sustainability, including social, economic and environmental aspects together.

Policy coherence has been seen as critical to effectively implementing these two global agendas. Defined as "a process of policy-making that systematically considers the pursuit of multiple policy goals in a coordinated way, minimising trade-offs and maximising synergies" (Nilsson, 2021, p. 2), policy coherence first gained traction in the European Union in the 1990s, when it was used synonymously with policy coordination, policy integration and "joined-up government". Since the adoption of the 2030 Agenda, with its emphasis on the "integrated" and "indivisible" nature of its 17 SDGs, policy coherence has been the subject of renewed interest (McGowan et al., 2019). Its perceived importance is reflected in the inclusion of a specific target, SDG 17.4 (policy coherence for sustainable development). Proponents of the 2030 Agenda, and even some of its detractors, have argued that coherence is vital to effective implementation of the SDGs and to navigate trade-offs in a transparent and equitable manner (Easterly, 2015).

In this paper, we assess the potential for policy coherence between the Paris Agreement and the SDGs by applying a systems approach to their interactions. The Paris Agreement goal of pursuing efforts to limit global warming to 1.5°C imposes a boundary condition on the world's development pathways, which is likely to constrain development trajectories in order for them to be climate-resilient and climate-compatible. Our objective is to shed light on how this boundary condition influences the achievement of the SDGs.

More specifically, we focus on how a 1.5°C boundary condition may generate synergies and trade-offs between specific SDG targets that are of particular importance from a climate change perspective. We used the SDG Synergies methodology (Weitz et al., 2019b) to systematically explore synergies and trade-offs between the Paris Agreement and the SDGs. Understanding how interactions between the two agendas might play out can inform improved policymaking and cross-institutional collaboration; these improvements can, in turn, enable the implementation of policy coherence measures to ensure concurrent progress on both climate and development goals (Brandi et al., 2017; Dzebo et al., 2018).

This paper identifies the most important synergies and trade-offs between the SDGs and the Paris Agreement climate goals at the global level. It provides theoretical groundwork for future empirical analysis that can explore the most interesting points of interactions through, for example, a correlation-based indicator analysis (Kroll et al., 2019; Pradhan et al., 2017; Warchold et al., 2021), as well as national, regional or comparative case study analysis (Hernández-Orozco et al., 2022), to assess whether and how key synergies and trade-offs identified at the global level are manifesting on the ground in different country contexts.

One often-expressed concern is that the consequences of efforts to address climate change will fall disproportionately on some sectors and groups, particularly socially, economically and politically vulnerable groups (Campagnolo & Davide, 2019; Markkanen & Anger-Kraavi, 2019). This raises questions about the implications of pursuing development goals in a climate-constrained world for reducing inequality, and whether progress can be made on the global climate and development agendas without exacerbating inequality. In our future work, we aim to go beyond conventional theoretical analyses of SDG interactions by also exploring whether, how and why synergies, trade-offs and conflicts identified by experts are being realized on the ground.

The next section of this paper provides an overview of the literature on SDG interactions and demonstrates how our approach builds on and complements existing work. Following that, section 3 presents our novel methodological approach, including critical reflections on contributions and limitations. Section 4 presents and discusses our results within the broader literature on climate change and sustainable development. Finally, section 5 concludes with key findings and next steps for future research.

2. Overview of literature on SDG interactions

Several studies have analysed the theoretical interactions between SDGs, finding them to be broadly synergistic, with a limited number of significant trade-offs (Janetschek et al., 2019; Miola et al., 2019). However, these exercises have predominantly taken a geographically delimited (e.g. national, regional or local; Barquet et al., 2019; Järnberg et al., 2021) or a sectoral (e.g. energy, water, agriculture) approach (Weitz et al., 2019a), rather than exploring global-level interactions.

For example, Järnberg et al. (2021) assessed SDG interactions specifically in Sri Lanka and found that only 2% of interactions involve a trade-off. Fuso Nerini et al. (2019) took a more global approach, but they looked only at interactions between climate action (i.e. SDG 13) and SDG targets, rather than between SDG targets themselves within a climate-limited context.

Moving beyond the theoretical level, a systematic review of the literature on SDG interactions found a critical gap for studies that complement SDG interactions with an analysis of global indicators and how they interact (Bennich et al., 2020). Those studies that have undertaken this approach have utilized correlation analyses, categorizing positive correlations between indicators as synergies and negative correlations as trade-offs (Kroll et al., 2019; Pradhan et al., 2017). Methods combining the theoretical approach of assessing interactions with indicator analyses remain limited. One exception is a principal component analysis by Hegre et al. (2020), where the authors found some evidence between theoretical synergies between SDG targets and global indicators, with the exception of SDG 10, "Reduced inequalities".

Other studies have noted that countries' commitments under the Paris Agreement, especially commitments to reduce emissions, have the potential to undermine or inhibit progress toward a range of development goals (Cohen et al., 2021; Shachi & Ram, 2021; Viguié & Hallegatte, 2012). For example, Cohen et al. (2021) identified potential negative implications of climate mitigation for land use and energy access. Climate adaptation actions can also sometimes undermine achievement of SDGs by exacerbating social vulnerability, inequity and uneven power relations, particularly if the root causes of vulnerability are not accounted for (Antwi-Agyei et al., 2018; Atteridge & Remling, 2018).

Meanwhile, most work on policy coherence between the Paris Agreement and the 2030 Agenda has focused on exploring synergies (Bastos Lima et al., 2017; Collste et al., 2017), emphasizing certain SDGs or sectors (Di Gregorio et al., 2017; Kanter et al., 2018) or providing a "superficial" analysis at the goal level, rather than exploring specific targets (Bastos Lima et al., 2017; Hutton et al., 2018). This raises the question of the extent to which the global climate and development agendas are truly synergetic, and whether they can be implemented in a coherent manner across different contexts.

We address these gaps by going beyond regional and sectoral studies of SDG interactions to conduct a global assessment of synergies and trade-offs between key SDG targets from a climate change perspective. Utilizing the well-established methodology of employing a cross-impact matrix to assess interactions (Nilsson et al., 2016; Weitz et al., 2017), our assessment complements existing studies by applying a boundary condition of pursuing efforts to limit temperature increase to 1.5°C, and we explore the resulting interactions at the global level. We also expand

on existing global studies that investigate synergies (Janetschek et al., 2019) to also uncover trade-offs and potential goal conflicts. We aim to provide an underlying basis that can be used for empirical analyses to complement existing studies (Bennich et al., 2020; Kroll et al., 2019).

3. Methods

Our methodological approach draws on Stockholm Environment Institute's (SEI) existing tools and global expertise in climate change and sustainable development. First, we used SEI's NDC-SDG Connections tool (Brandi et al., 2017) , which connects activities reported in countries' Nationally Determined Contributions (NDCs) under the Paris Agreement to the 17 SDGs and their targets. It shows not only which SDGs are most relevant to climate action, but also which targets within the specific SDGs are most reflected in countries' NDCs (Dzebo et al., 2018). This enabled us to employ a climate lens in our selection of targets.

Using the tool, we listed those SDG targets that were the most relevant for each goal, first selecting the SDGs with a high number of connections to NDC activities. For those SDGs with a lower number of connections (i.e. fewer total number of activities in NDCs), we included those SDGs with one or two targets that reflect the overwhelming majority of the total number of NDC activities.[1] For example, while SDG 10 "Reduced inequality" is not strongly reflected in the total number of activities to which countries have committed in their NDCs, target 10.2 on social, political and economic inclusion was nevertheless included due to its relative "size" (number of connections) compared with other targets in this goal.

Due to thematic overlaps, some SDG targets were merged during the selection process. For example, targets 1.2 and 10.1 emphasize poverty reduction and income growth, respectively, which can be seen as two sides of the same coin. In this case, the two targets were merged to better reflect the breadth of the SDG targets. For all targets that were merged, the research team put together a "target operationalization" for each pairing; this provided critical information on how the targets are understood and interpreted within the context of our project. This process yielded a total of 21 targets (Table 1).

We then used the SDG Synergies tool (Hernández-Orozco et al., 2022), also developed by SEI, to assess target interactions. This semi-quantitative tool facilitates systemic analysis of interactions between sets of policy targets and goals. It does so in a way that reflects the real-world context in which implementation will happen. SDG Synergies combines qualitative assessment of target interactions – informed by scientific evidence, broad-ranging stakeholder involvement, or both – with quantitative network analysis. This combination enables analysis of complex and systemic relationships between targets. The tool applies a seven-point scale to better capture the intensity and character of target interactions. This approach simplifies the complexity of dealing with large numbers of target interactions and captures how progress towards one target could affect progress in a broad range of targets and associated policies, in a specific setting (Barquet et al., 2021; Hernández-Orozco et al., 2022; Weitz et al., 2019b).

In contrast to most studies using the SDG Synergies approach, this study focuses on global interactions. However, how interactions play out depends on the context (Nilsson et al. 2016). Therefore, in order to provide a global context for scoring the interactions, the research team extracted relevant information from the IPCC 1.5°C Special Report (IPCC, 2018) and the Paris Agreement (UNFCCC, 2015) pertaining to each target. These statements were used to provide evidence of synergies, trade-offs and general linkages between climate change and the selected SDG targets. Based on this data, the research team put together a short "narrative" for each target; this served as the initial basis for the scoring.

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1   For more information on the methodology behind the NDC-SDG Connection tool, please see here: https://klimalog.die-gdi.de/ndc-sdg/assets/downloads/How%20did%20we%20do%20this%20-%20NDC%20SDG%20Connections.pdf

Table 1. Selected targets and their interpretation (operationalization) within the context of this project

Selected target	Operationalization
1.2 and 10.1: poverty and inequality	Decrease poverty by at least half and sustain income growth for the bottom 40% of the population through increased wealth and improved livelihoods at a rate higher than the national average.
1.5 and 11.5: resilience and vulnerability	Build resilience and develop adaptive capacity of the poor and most vulnerable to reduce their exposure and vulnerability to disasters and extreme events and mitigate number of deaths, socio-economic losses and loss of livelihood.
2.4: food production	Develop climate-resilient and sustainable food production systems, climate-smart agriculture and ecosystem protection to ensure strengthened capacity for adaptation to climate change and extreme weather events.
3.3: health and diseases	Reduce the number of infected or to eradicate the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases.
3.8: universal healthcare	Achieving universal access to safe, effective, quality and affordable healthcare, health insurance and medication and vaccines.
6.1 and 6.4: water security	Ensure safe, universal, equitable and affordable water availability for all, including implementing water efficiency measures and ensuring sustainable withdrawals and supply of freshwater.
6.6 and 14.2: water-related ecosystems	Protect, sustainably manage and restore water-related ecosystems, including increasing the resilience of coastal and marine ecosystems.
7.1: energy access	Increase access to affordable, reliable and modern energy for those that currently do not have this access.
7.2: renewable energy	Scale-up and development of renewable energy technologies, including solar, wind, water, wave, tidal, geothermal, etc.
7.3: energy efficiency	Improve energy efficiency and lower the current energy outputs, particularly of fossil fuelled-driven energy, keeping in mind the Jevons paradox.
8.1: economic growth	Achieve and maintain sustained economic growth in developing countries and particularly least developed countries (LDCs).
8.4: resource efficiency	Decouple resource intensity and environmental degradation from economic growth and reduce the negative impact from consumption and production practices, particularly in developed countries.
9.2: urbanization and industrialization	Create inclusive and sustainable urbanization and industrialization by increasing the share of industrial jobs (in relation to other sectors, e.g. agriculture) in developing countries and particularly LDCs.
9.4 and 9.1: sustainable infrastructure	Reduce resource intensity and increase resilience and efficiency of existing and new infrastructure and industry, for example through adoption of new technologies, to support economic development and human well-being, with a focus on affordable and equitable access for all.
10.2: empowerment and inclusion	Increase empowerment and promote inclusion of all, particularly vulnerable and marginalized communities, to reduce inequality and systemic discrimination and exclusion.
11.2: sustainable transport	Increase access to safe, affordable, accessible and sustainable public and private communal transport systems, with special attention to the needs of those in vulnerable situations.
12.4 and 3.9: waste and pollution	Improve waste management and reduce deaths from pollution and hazardous chemicals, in order to improve human and environmental health.
13.2: climate policy	Mainstreaming of climate change into national policies, strategies and budgets.
14.7: marine-based economy	Increase the share of marine-based economy as part of the total economic output in Small Island Developing States and LDCs, including through sustainable management of fisheries, aquaculture and tourism.
15.2, 15.3 and 15.5: ecosystems and biodiversity	Implement sustainable management of forests, land restoration and reduction of deforestation in order to maintain and increase existing forest cover, increase overall levels of biodiversity, and decrease and reduce desertification, soil degradation and habitat loss.
17.3: climate finance and ODA	Increase the total flows of ODA, climate finance and other development financial flows, both public and private, to developing countries.

Another way that we applied the SDG Synergies methodology differently is in our scoring approach. Mainly used in geographical or sectoral contexts, SDG Synergies is primarily applied in a participatory approach that aims to capture the attitudes and values of actors involved in decision-making and implementation. This usually takes place in a workshop setting (see e.g. Barquet et al., 2019, 2021; Järnberg et al., 2021; Weitz et al., 2019a). This approach is very useful for guiding on-the-ground decision-making. For this paper, where we apply a global approach, we asked sector experts to assess a subset of interactions based on their individual experience.

In order to conduct the scoring, the research team selected one or two "target representatives" for each of the 21 targets. The representatives are researchers from SEI's seven centres and were selected to represent targets based on their areas of expertise (Table 2). The geographical location of SEI's research centres ensures a good balance between experts selected from the global North and South, with five different continents represented. Moreover, the many nationalities and areas of expertise within SEI ensures a good spread of scoring candidates.
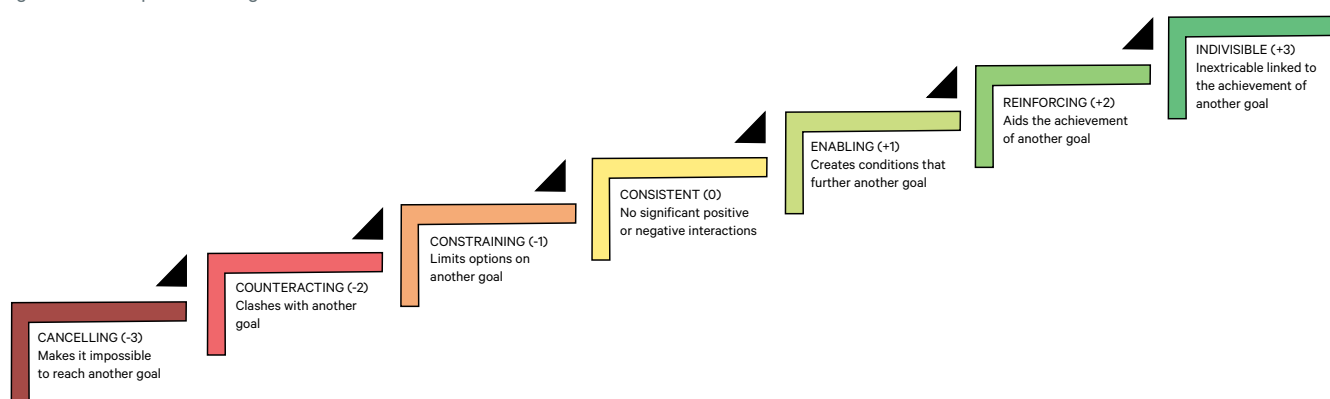
Table 2. Geographical distribution of SEI experts

SEI Centres	SEI HQ	SEI Africa	SEI Asia	SEI Latin America	SEI York	SEI Tallinn	SEI US
No of experts involved	13	4	5	2	4	2	3

Each target representative was provided with a "codebook" that detailed the SDG Synergies methodology, the narrative and operationalization for each target, and the instructions for scoring. When conducting the scoring, the representatives were asked to consider the following question: "When pursuing efforts to limit temperature increase to 1.5°C above pre-industrial levels, to what extent and how does progress on your target influence progress on target x?" Adding the 1.5°C Paris Agreement goal to this question enabled us to impose a climate-related boundary condition on the scoring, to be able to assess synergies and trade-offs between targets in a world where climate change imposes limits on the policy options available to achieve targets.

Scoring was done using a seven-point scale (see Figure 1), ranging from "restricting" interactions, i.e. cancelling (–3), counteracting (–2) and constraining (–1), to "promoting" interactions, i.e. enabling (+1), reinforcing (+2) and indivisible (+3). A score of 0 is consistent, meaning there is no significant interaction (Nilsson et al., 2016).

Figure 1. Seven-point scoring scale

CANCELLING (-3)
Makes it impossible to reach another goal

COUNTERACTING (-2)
Clashes with another goal

CONSTRAINING (-1)
Limits options on another goal

CONSISTENT (0)
No significant positive or negative interactions

ENABLING (+1)
Creates conditions that further another goal

REINFORCING (+2)
Aids the achievement of another goal

INDIVISIBLE (+3)
Inextricable linked to the achievement of another goal

Target representatives were asked to score interactions on their specific target (i.e. area of expertise). Once data on scoring was gathered from all representatives, the research team entered the data into the online SDG Synergies tool[2] in order to generate a matrix of key synergies and trade-offs. In cases where the target representatives provided different scores for a specific interaction, the research team discussed and selected the appropriate score, based on the justification provided by the representatives. We preferred this approach over the use of numerical scores or aggregation, as it enabled us to be more qualitative in accounting for the justification of the scoring provided and use the expert opinion justification to determine the score that would fit best. We believe that this resulted in a more accurate score than a numerical or aggregating approach.

We recognize that our results may be limited by methodological challenges, such as our reliance on experts from one institution (albeit at different geographical locations) to conduct the scoring; our selection and merging of specific targets based on our own judgements; and our selection of the final score based on the justification provided in cases where the scores did not align. Despite this, we contend that this analysis provides a useful baseline of perceptions of interactions at the global level, which we can then empirically explore further in different contexts where policy coherence is important for the implementation of the two agendas, including national, local and sectoral. As Weitz et al. (2019b) noted, methodological learning outcomes can be just as valuable as the analytical outputs themselves.

4. Results

Overall, when taking climate change into consideration, our analysis shows that the interactions between our selected SDG targets are generally positive. We find 261 synergetic interactions and 48 potential trade-offs (representing around 62% and 11% of total interactions respectively) between the 21 targets (see Figure 2). In addition, this exercise found that 111 interactions (about 27%) were neither restricting nor promoting.

These results indicate that hypothetically, at the global level, imposing a boundary condition of 1.5°C should still enable progress towards achieving the 2030 Agenda. This finding has implications for opening up pathways of climate-resilient development in different contexts (Denton et al., 2014), with the potential for policy avenues and options that enable achievement of most SDGs while still limiting temperature increase to 1.5°C.

To rank the interactions between the selected targets, we examined outcomes from two different approaches. First, we considered the "outward influence" of interactions, i.e. which targets have the most promoting or restricting direct influence on progress towards the other targets. Second, we considered the "inward influence" of interactions, i.e. how progress towards a given target is directly influenced by progress on the others.

The rankings are not in themselves priority lists of the importance of targets. All targets included in this analysis have been selected as priority targets for the two agendas. Rather, rankings provide information about the implications of prioritizing certain targets. They can be a useful way to identify priority areas that can enable progress on both the Paris Agreement and the 2030 Agenda. Thus, from a policy coherence perspective, both top- and bottom-ranking targets play an important role for implementation.

A high sum (or high synergetic potential) indicates that making progress on this target would be beneficial for progress on most or all other targets (Barquet et al., 2019). Targets with strong outward influence can be seen as accelerators for making progress on the two agendas as a

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2   https://www.sdgsynergies.org/

Figure 2. Overall results of scoring
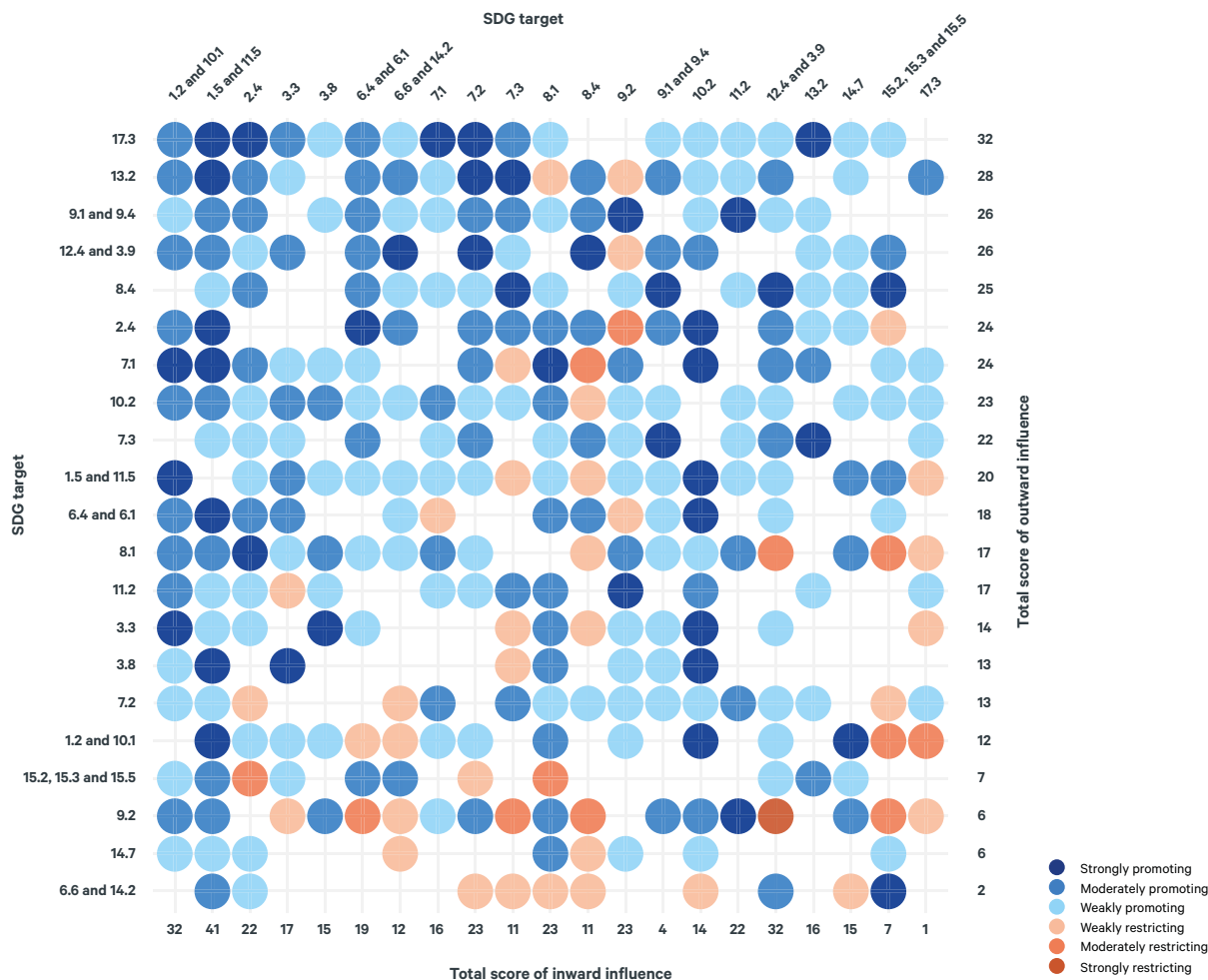
Left axis and the upper side show the specific SDG target(s). Right axis and the bottom side summarize the aggregate scoring number for each target. The right axis shows the row-sum for total score of outward influence and bottom axis shows the column sum for the total score of inward influence.

whole. A low sum (or low synergetic potential) indicates that progress on that target would have little effect on the achievement of other targets, despite the value of achieving that specific target. Targets can also have negative sums, which indicates that implementation of that specific target would restrict progress on achieving on most (or all) other targets (Järnberg et al., 2021).

The most influential targets according to our rankings are 17.3 and 13.2, on climate finance and ODA and on climate policy mainstreaming, respectively. This ranking means that progress on these two targets would be highly beneficial for the achievement of other targets. Also notable are targets focusing on sustainable infrastructure (9.4 and 9.1) and waste and pollution (3.9 and 12.4). The target with the lowest outward sum, or influence on achieving other targets, is the combined target 6.6 and 14.2, water-related ecosystems; this ranking indicates low capacity to positively influence other targets. In other words, making progress on this target would do little for making progress on all other targets selected. See Table 3 for the ranking of all the targets according to their influence on other targets.

Table 3. Ranking of outward influence

Selected target	Outward sum
17.3: climate finance and ODA	32
13.2: climate policy mainstreaming	28
9.4 and 9.1: sustainable infrastructure	26
3.9 and 12.4: waste and pollution	26
8.4: resource efficiency	25
2.4: food production	24
7.1: energy access	24
10.2: empowerment and inclusion	23
7.3: energy efficiency	22
1.5 and 11.5: resilience and vulnerability	20
6.1 and 6.4: water security	18
8.1: economic growth	17
11.2: sustainable transport	17
3.3: health and diseases	14
3.8: universal healthcare	13
7.2: renewable energy	13
1.2 and 10.1: poverty and inequality	12
15.2, 15.3 and 15.5: ecosystems and biodiversity	7
9.2: urbanization and industrialization	6
14.7: marine-based economy	6
6.6 and 14.2: water-related ecosystems	2

We also ranked inward influence, or the extent to which progress on a specific target is influenced by other targets (Table 4). A high score indicates that progress on most or all other targets is highly beneficial for achieving that specific target, whereas a low score indicates that progress on all other targets would be least beneficial for making progress on this target. Progress on targets with strong inward influence can, in theory, follow from joint progress on all, or most, other targets. Conversely, lack of progress or regression on the two agendas as a whole can be highly detrimental to these targets (Järnberg et al., 2021).

We found that target 1.5 and 11.5 (resilience and vulnerability) as well as targets 1.2 and 10.1 (poverty and inequality) and 10.2 (empowerment and inclusion) would most strongly benefit from the achievement of other goals. Meanwhile, target 17.3 on climate finance and ODA scores the lowest, meaning that progress or achievement of other goals would be least beneficial for the delivery of climate and development finance.

Below we focus on the most interesting and relevant policy implications from the analysis, concentrating both on inward and outward influences and on interactions with strong synergetic potential, as well as those with low synergetic potential and those that cause certain trade-offs. Our results are more multifaceted than the results presented below. However, rather than presenting a complete systematic analysis of the full set of interactions, our priority in this paper is to examine the most relevant and interesting insights from a policy coherence perspective (see e.g. Shawoo et al., 2020, 2022), which also have the most significant implications for our future empirical work.

Table 4. Ranking of inward influence

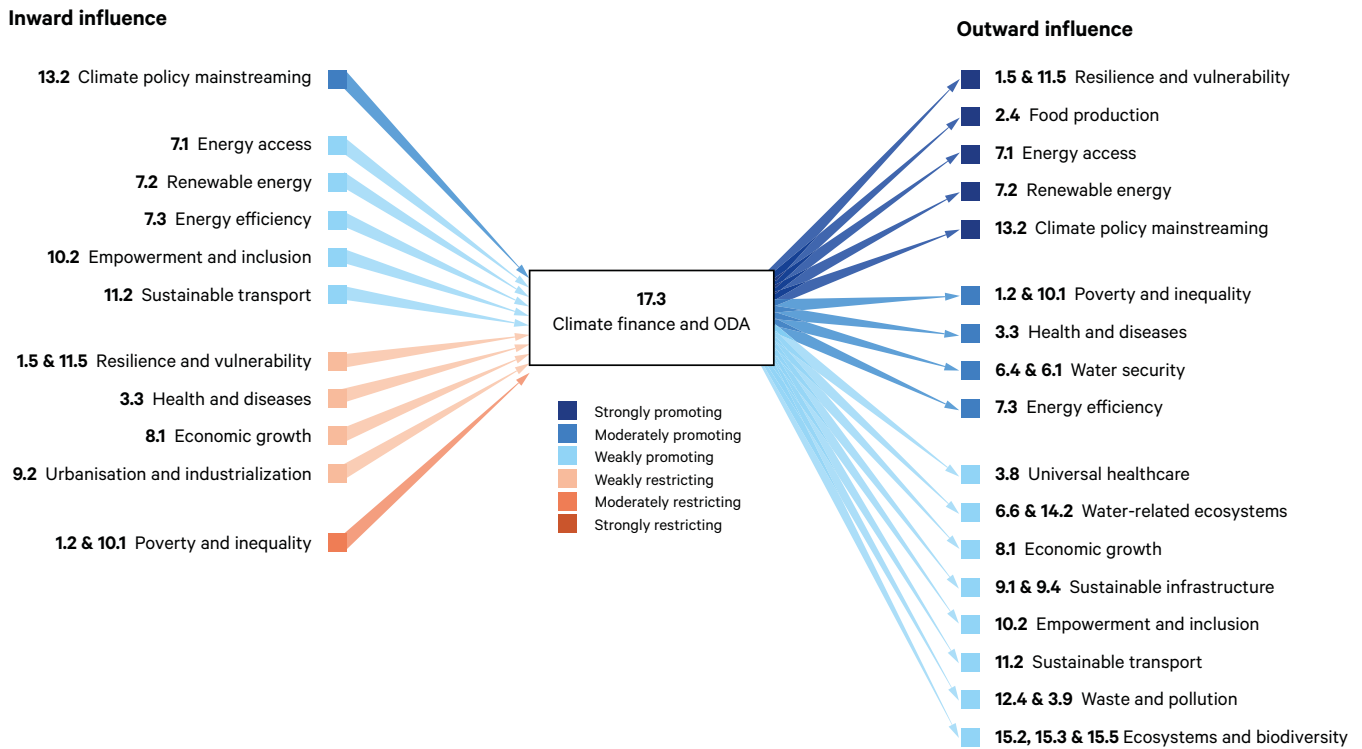| Selected target	Inward sum
1.5 and 11.5: resilience and vulnerability	41
1.2 and 10.1: poverty and inequality	32
10.2: empowerment and inclusion	32
7.2: renewable energy	23
8.1: economic growth	23
2.4: food production	22
9.1 and 9.4: sustainable infrastructure	22
6.1 and 6.4: water security	19
3.3: health and diseases	17
3.9 and 12.4: waste and pollution	17
7.1: energy access	16
11.2: sustainable transport	16
13.2: climate policy mainstreaming	16
3.8: universal healthcare	15
14.7: marine-based economy	15
9.2: urbanization and industrialization	14
6.6 and 14.2: water-related ecosystems	12
7.3: energy efficiency	11
15.2, 15.3 and 15.5: ecosystems and biodiversity	7
8.4: resource efficiency	4
17.3: climate finance and ODA	1

4.1 Scaling up climate and development finance

Climate finance and ODA (17.3) has the highest synergetic effect on all other targets, according to our results (Table 3), which means that making progress on mobilizing climate finance and increasing ODA to developing countries would be highly beneficial for the achievement of all other targets. For example, in order to achieving the Paris Agreement, including the 1,5°C goal, almost 100 countries specify in their NDCs that their activities are dependent on mobilization and delivery of additional climate and development finance (Pauw et al., 2018).

Overall, progress on climate finance and ODA is likely to be most strongly "promoting" for the following targets in our assessment, illustrated by Figure 3: mainstreaming climate change into national policies (13.2), building resilience of poor and vulnerable communities (1.5 and 11.5), developing climate-resilient and sustainable food production systems (2.4), increasing access to affordable, reliable and modern energy (7.1), and scaling up renewable energy technologies (7.2). Our results also indicate that scaling up climate finance and ODA does not have negative interactions with any other target. This highlights the central role of finance in making progress on climate mitigation and adaptation globally and ensuring that progress on SDGs is aligned with the goals of the Paris Agreement.

While mobilization of climate and development finance can be seen as an "accelerator" target for implementing the two agendas, our analysis shows that the same target has the lowest inward influence (Table 4). Thus, realizing all other targets influences this target least positively, so to speak, or in a way that makes target 17.3 unnecessary. Theoretically, progress on other targets – particularly reducing poverty and decreasing inequality, but also targets on health and diseases, economic growth, urbanization and industrialization, and resilience and vulnerability – would reduce the need for more climate and development finance, as international development is the primary purpose of climate finance and ODA. However, while this target has overall low inward

Figure 3. Outward influence of target 17.3 (climate finance and ODA)

Inward influence

13.2 Climate policy mainstreaming

7.1 Energy access
7.2 Renewable energy
7.3 Energy efficiency
10.2 Empowerment and inclusion
11.2 Sustainable transport

1.5 & 11.5 Resilience and vulnerability
3.3 Health and diseases
8.1 Economic growth
9.2 Urbanisation and industrialization

1.2 & 10.1 Poverty and inequality

17.3
Climate finance and ODA

Strongly promoting
Moderately promoting
Weakly promoting
Weakly restricting
Moderately restricting
Strongly restricting

Outward influence

1.5 & 11.5 Resilience and vulnerability
2.4 Food production
7.1 Energy access
7.2 Renewable energy
13.2 Climate policy mainstreaming

1.2 & 10.1 Poverty and inequality
3.3 Health and diseases
6.4 & 6.1 Water security
7.3 Energy efficiency

3.8 Universal healthcare
6.6 & 14.2 Water-related ecosystems
8.1 Economic growth
9.1 & 9.4 Sustainable infrastructure
10.2 Empowerment and inclusion
11.2 Sustainable transport
12.4 & 3.9 Waste and pollution
15.2, 15.3 & 15.5 Ecosystems and biodiversity

influence, several individual targets, such as broad mainstreaming of climate policy (13.2), increase in energy access (7.1), renewable energy (7.2) and energy efficiency (7.3), among others, would strongly promote the need for investments in climate-related activities in developing countries, both domestically and globally, which would increase the demand for scaling up climate and development finance mobilization and delivery.
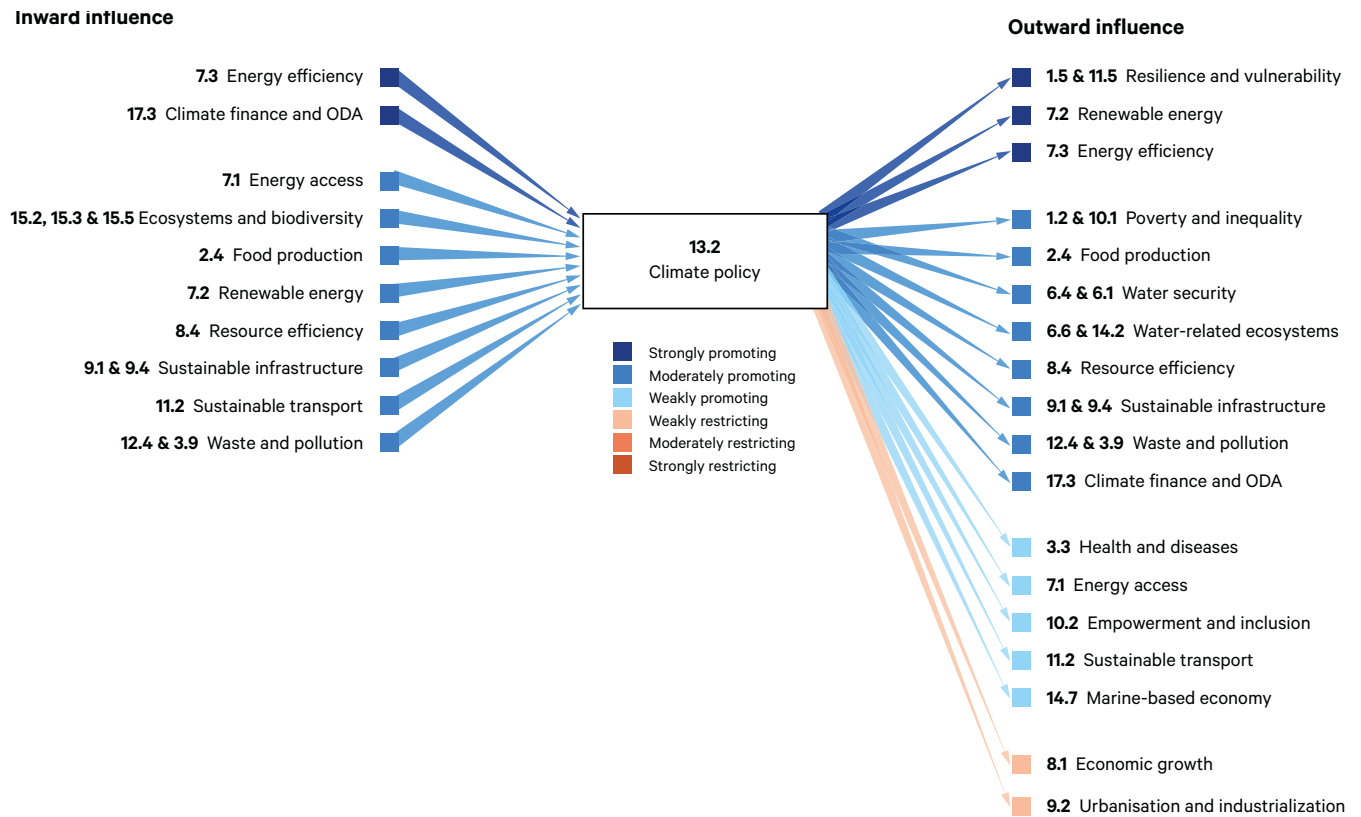
4.2 Mainstreaming climate change for policy coherence

Target 13.2 (climate policy mainstreaming) is ranked second for outward influence (Table 3). This target emphasizes the importance of ensuring climate change is mainstreamed and addressed by all national policies, strategies and budgets, for making progress on both the goals of the Paris Agreement and the achievement of other SDGs.

Effective mainstreaming of climate change requires integrated policymaking that incorporates horizontal policy coherence across sectors and vertical policy coherence across different government levels, as well as ensuring inclusion and participation of all relevant stakeholders (UN Department of Economic and Social Affairs, 2018). This requirement is in line with the broader literature on policy coherence for sustainable development, which calls for better alignment between climate and development policies through incorporating climate goals into national budgeting, adopting "whole-of-government" approaches to climate policies, and designing climate-compatible development agendas, alongside improved coordination and communication between ministries, departments and agencies at all levels (Antwi-Agyei et al., 2017; Dzebo et al., 2019; Nilsson & Weitz, 2019; OECD, 2018).

As illustrated in Figure 5, progress on mainstreaming of climate policies has almost only positive (inward and outward) interactions with other targets. It shows strongest synergies with the target on resilience and vulnerability (1.5 and 11.5) and the two energy-related targets on renewable energy (7.2) and energy efficiency (7.3). Just below these, climate mainstreaming has a promoting

Figure 5. Outward influence of target 13.2 (climate policy)

Inward influence

7.3 Energy efficiency
17.3 Climate finance and ODA

7.1 Energy access
15.2, 15.3 & 15.5 Ecosystems and biodiversity
2.4 Food production
7.2 Renewable energy
8.4 Resource efficiency
9.1 & 9.4 Sustainable infrastructure
11.2 Sustainable transport
12.4 & 3.9 Waste and pollution

13.2
Climate policy

Strongly promoting
Moderately promoting
Weakly promoting
Weakly restricting
Moderately restricting
Strongly restricting

Outward influence

1.5 & 11.5 Resilience and vulnerability
7.2 Renewable energy
7.3 Energy efficiency

1.2 & 10.1 Poverty and inequality
2.4 Food production
6.4 & 6.1 Water security
6.6 & 14.2 Water-related ecosystems
8.4 Resource efficiency
9.1 & 9.4 Sustainable infrastructure
12.4 & 3.9 Waste and pollution
17.3 Climate finance and ODA

3.3 Health and diseases
7.1 Energy access
10.2 Empowerment and inclusion
11.2 Sustainable transport
14.7 Marine-based economy

8.1 Economic growth
9.2 Urbanisation and industrialization

effect on efforts to reduce poverty and inequality (1.2 and 10.1). The figure also illustrates that, in terms of inward influence, all other targets that interact with climate mainstreaming are positive, of which energy efficiency (7.3) and climate finance and ODA (17.3) are the most important.

While mainstreaming climate policy has interactions with other targets that are mostly synergetic in our assessment, this target slightly restricts the targets on economic growth (8.1) and urbanization and industrialization (9.2). This minor restricting influence is likely due to the high emissions potential of these targets; as the mainstreaming of climate policies is intended to lead to lower emissions of greenhouse gases, this could counteract achieving these targets (Berkhout et al., 2015). For example, mainstreaming climate change into national budgets could redirect investments away from business as usual, such as fossil fuel subsidies, which could lead to an overall reduction in economic growth in the short term.

Given the positive interactions between climate mainstreaming and most other targets, the results of our assessment emphasize that effective mainstreaming of climate policy needs to incorporate both adaptation- and mitigation-oriented goals and objectives. In addition, the strong importance climate mainstreaming has on efforts to achieve the targets on decreasing vulnerability, poverty and inequality highlights the link between policy coherence and mainstreaming measures on the one hand and climate justice, just transitions and redistributive policies on the other (Galgóczi, 2022; Lager et al., 2021).

4.3 Parallel progress needed for reducing vulnerability, poverty and inequality

Lack of progress on the two agendas of reducing climate change and achieving the SDGs together will be most detrimental for achieving goals on vulnerability, poverty and inequality. This theoretically implies the critical role of policy coherence for equitable action on the Paris Agreement and the 2030 Agenda.

First, realizing all targets to the utmost will have a strong positive effect on efforts to increase resilience and decrease vulnerability (1.5 and 11.5). This means that making progress on most or all other targets would lead to greater resilience to cope with climate impacts and reduced vulnerability to climate events. As illustrated in Figure 6, seven different targets have a strong promoting influence on resilience and vulnerability, including the target on decreasing poverty and inequality (1.2 and 10.1). This highlights the complementarity between resilience and vulnerability, on the one hand, and poverty and inequality, on the other. In other words, sustainable livelihoods for the poor will not be achieved without increasing adaptive capacity and building resilience to climate impacts (Hallegatte et al., 2018). Moreover, as illustrated in Figure 6, improving access to food, energy, water and healthcare is crucial for reducing vulnerability, poverty and inequality. This reinforces the highly synergetic nature of the development and climate change adaptation agendas, where development efforts are central to climate adaptation measures and outcomes (Roy et al., 2018).

Figure 6. Inward influence of target 1.5 and 11.5 (resilience and vulnerability)
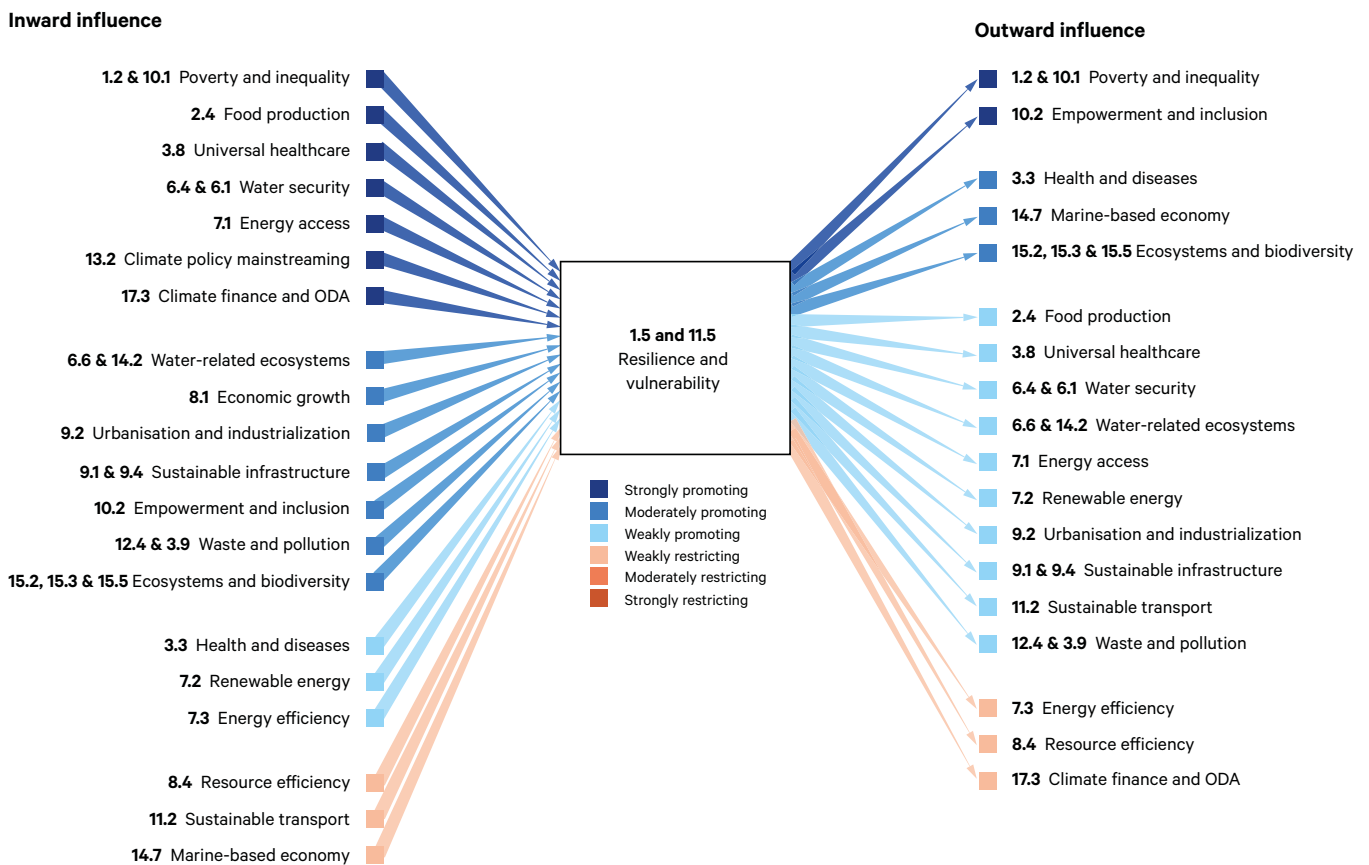
These results are in line with the broader literature on climate change adaptation and risk, which highlights the importance of addressing the root causes of vulnerability for making progress on development goals such as poverty reduction, health access, and food and water security in order to increase the resilience of populations against climate impacts (Eriksen et al., 2021; Pelling & Garschagen, 2019; Schipper, 2020; Thomas et al., 2019).

Second, our results show that poverty and inequality (1.2 and 10.1) and empowerment and inclusion (10.2) both rank second as being most strongly positively influenced by other targets (Table 4). What is also noteworthy is that for both targets, almost all (inward and outward) interactions are positive, indicating that increasing resilience and vulnerability while reducing poverty and inequality does not appear to cause trade-offs with other targets.

To effectively reduce poverty and inequality, our assessment shows that efforts should particularly focus on improving health and well-being (target 3.8) and energy access (7.1), as illustrated in Figure 7. More specifically, access to safe, effective, high-quality and affordable healthcare, provision of health insurance and access to medication and vaccines would strongly promote the synergetic effect, according to our assessment. Similarly, increasing access to affordable, reliable and "modern" energy for those who currently do not have it is crucial. This once again demonstrates the potential to synergetically promote climate adaptation and meet development goals if the root causes of vulnerability are addressed.

Figure 7. Inward influence of target 1.2 and 10.1, poverty and inequality
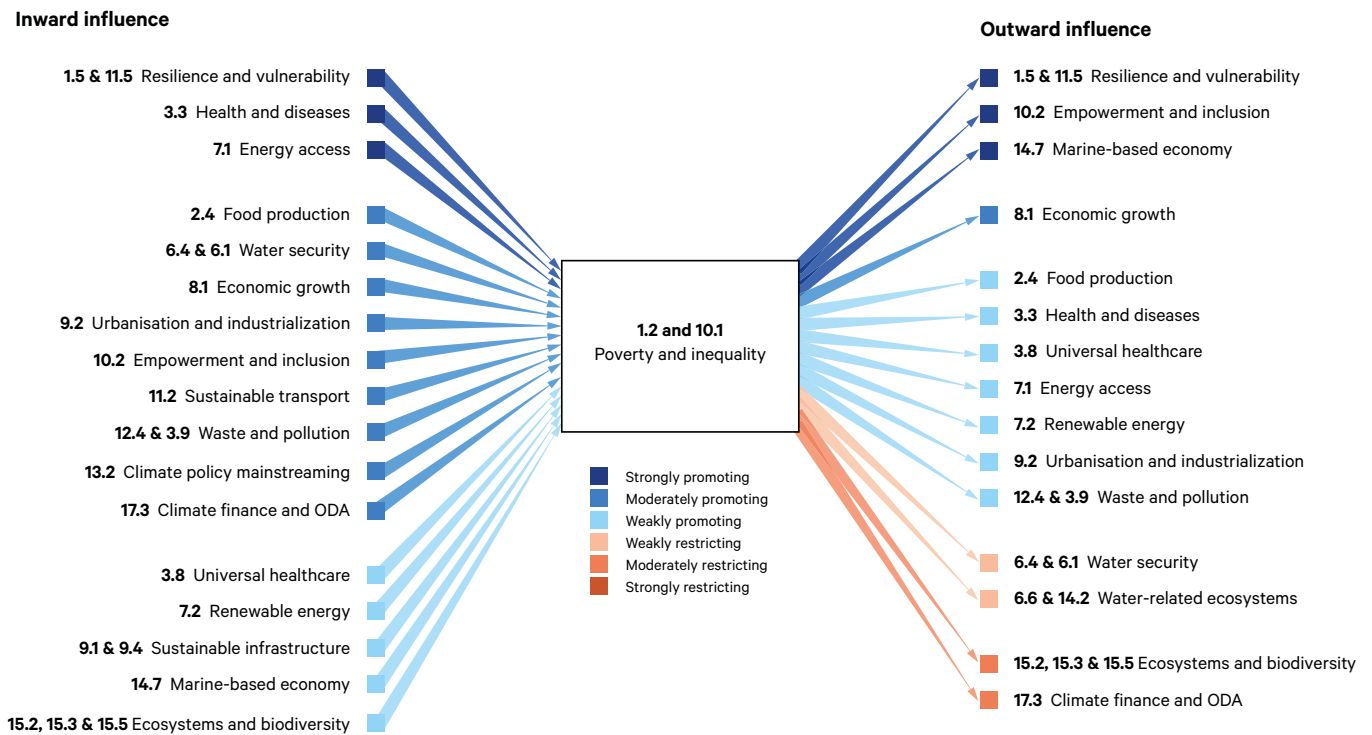
Similarly, as Figure 8 shows, achieving most other targets has a strong positive influence for efforts to achieve inequality reduction through empowerment and inclusion (target 10.2), with seven different targets having a strong promoting influence. This result from our assessment indicates that it should be possible to implement both agendas without increasing inequality. Addressing distributional impacts and inequality emerges as a critical requirement for climate action and sustainable development, and vice versa (Saiz & Donald, 2017). The result also highlights the crucial role of multiple development goals such as access to enough food, healthcare, water and energy for reducing inequality, which as discussed above are also critical for adapting to climate change through building resilience and reducing vulnerability (Gupta et al., 2022; Gupta & Vegelin, 2016).

Figure 8. Inward influence of target 10.2 (empowerment and inclusion)
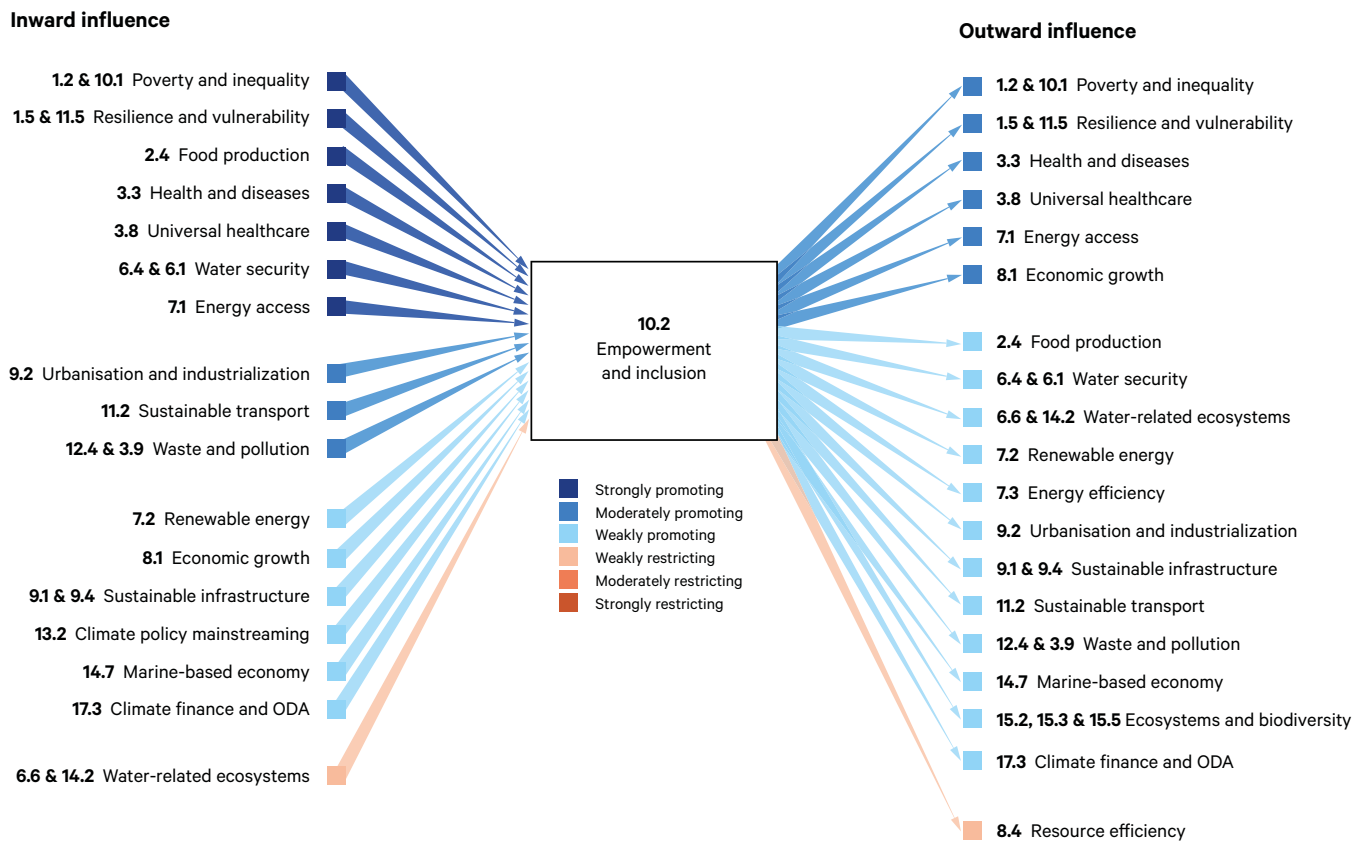
5. Discussion and conclusion

Our assessment provides insights into the potential for policy coherence between the Paris Agreement and the 2030 Agenda. We have assessed the synergies and trade-offs between those SDG targets that are the most important when viewed through a climate lens, based on experts' perceptions of their interactions in the context of a 1.5°C boundary condition. Our main finding is that the SDG targets are largely synergetic with one another at the global level.

This finding raises the question of the extent to which these synergies can be harnessed through policy measures at the national level and within different contexts. Another question is whether the implementation of these targets would create new trade-offs that emerge as a result of varying ideologies, power dynamics and vested interests that can shape how coherently policies are implemented (Shawoo et al., 2022).

Our assessment reveals the critical role of climate and development finance in achieving the SDG targets selected, highlighting the potential co-benefits of climate finance for not only climate mitigation and adaptation, but also for sustainable development and particularly for building resilience more broadly. Therefore, our findings justify the need to rapidly scale up and deliver climate finance under the UN climate architecture to ensure that development gains in the global South can be protected (see also Bracking & Leffel, 2021).

It is, however, important to emphasize that climate finance mobilization and delivery remain a key point of contention in climate negotiations, in which developing countries are demanding support for dealing with a problem that they did not cause to enable them to mitigate emissions and adapt to climate impacts (Pickering et al., 2015). Particularly important has been the need to mobilize USD 100bn in climate finance per year by 2020, an as-yet unmet commitment to which countries agreed at the UN climate conference in Copenhagen in 2009 and reaffirmed in Paris in 2015 (Timperley, 2021). Furthermore, as Pauw et al. (2022) noted, issues around transparency, accountability and trust in climate and development finance continue to be contentious in climate change negotiations.

We also show that the mainstreaming of climate policy across institutional settings is a crucial step for the achievement of the SDGs. This finding is similar to the work by Fuso Nerini et al. (2019), who argued that climate action can support the achievement of most SDGs. In other words, achieving both the Paris Agreement and the 2030 Agenda is dependent on effective policy coherence between climate change (mitigation and adaptation) and other sectors. However, literature is emerging that problematizes the role and importance of policy coherence in achieving goals equitably (Yunita et al., 2022), particularly in cases where policy coherence is understood from a technical perspective of increased institutional coordination (see e.g. OECD, 2018). As such, in addition to institutional effectiveness, policy coherence efforts need to account for more political dimensions such as actors' vested and material interests, as well as their ideological framing, in order to increase synergies and minimize trade-offs (Shawoo et al., 2022). This would influence the extent to which policy coherence measures lead to more equitable action on the two agendas, through accounting for whose interests and ideologies are being served over others when implementing multiple goals.

Finally, our analysis also exposes the dependence of targets – reducing inequality, poverty and vulnerability and on increasing resilience – on the broad achievement of both the 2030 Agenda as a whole and the Paris Agreement, particularly focusing on adaptation. Targets that aim to address the root causes of vulnerability such as increased health, water, food and energy access, as well as poverty and inequality reduction, appear to be highly beneficial for building resilience to climate impacts. This justifies the need for coherence between climate adaptation and sustainable development strategies, particularly given that adaptation actions can inadvertently reinforce, redistribute or create new sources of vulnerability and undermine development without an understanding of local vulnerability contexts (Eriksen et al., 2021).

The UN has recognized the importance of an integrated approach on vulnerability, poverty and inequality, which is reflected in the concept of "Leave No One Behind". This mandate commits all UN Member States to eradicate poverty in all its forms, end discrimination and exclusion, and reduce the inequalities and vulnerabilities that leave people behind and undermine the potential of individuals and of humanity as a whole (UN, 2017). Despite this, SDG 10 on reducing inequality has not received the same amount of political attention as many other goals. It received the least policy coverage in the Voluntary National Reviews (VNRs), which are the national reports on SDG implementation progress (UN-ECOSOC, 2019). At the same time, our previous research indicates that the role of inequality for the implementation of the Paris Agreement and the 2030 Agenda is becoming increasingly important, particularly from a policy coherence perspective, as it tends to lead to goal conflicts in national implementation (Shawoo et al., 2020, 2022). Moreover, despite widespread global adoption of the 2030 Agenda, no country is on track to achieve the SDGs (Biermann et al., 2022).

It is important to note that our methodological approach is as-yet novel and untested, and therefore has several challenges. Synergies and trade-offs remain context-dependent and do not exist in and of themselves but are determined by *how* and where climate goals and the SDGs are implemented, including what policy instruments are used to make progress on these global goals (Nilsson & Weitz, 2019; Toth et al., 2022). Given that there are different ways to make progress on a given target, scoring is highly judgement-based and dependent on the context and information available. This makes an "objective" assessment of synergies and trade-offs between the two agendas at the global level highly challenging (Barquet et al., 2021). While our use of the Paris Agreement and the IPCC 1.5°C Special Report to provide a global context, as well as our emphasis on utilizing *perceptions* of interactions, aims to mitigate this challenge, this still brings into question the validity of our results.

Notwithstanding, we contend that there is both a methodological and practical value in applying a global-level lens to SDG synergies. This working paper is a first step towards developing a novel methodological approach, and its purpose has been twofold – setting empirical foundations and laying the groundwork for national-level analysis, as follows.

In showing the most relevant synergies and trade-offs, this working paper lays the foundation for empirical analysis on how aligned the climate and development agendas are globally, which remains relatively unexplored within the literature. In addition, the analysis provides a baseline for exploring the nuances of national-level implementation. We intend to apply the global findings and assess the extent to which the theoretical synergies identified are actually being realized in different contexts.

First, we will use this analysis to empirically explore the interactions by using global indicator data. Through aggregating data from various indicators by SDG target, we will conduct statistical analyses to assess whether progress on specific targets within an interaction is being made simultaneously. This will enable us to explore whether the synergies or trade-offs at the global level are manifesting on the ground in similar ways.

Second, we will conduct national-level case studies in nine countries (Australia, Colombia, Fiji, Germany, Kenya, Philippines, Sri Lanka, South Africa and Sweden). This work will enable us to explore the political dimensions of policy coherence measures between climate change and sustainable development (Shawoo et al., 2022). These case studies will enable us to empirically answer the *why* question: specifically, why are or aren't synergies and/or trade-offs at the global level manifesting on the ground? What vested interests, ideologies or institutions are in place that may be inhibiting potential global-level synergies from being realized? We hope that these findings, combined with our future work, can generate policy recommendations for how expected synergies can be realized and trade-offs mitigated in different country contexts, to enable joint progress on climate change and sustainable development.

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