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Geographic SDG spillovers

How state-level policies influence the metropolitan level in Monterrey

SEI brief
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Key messages

- **The SDG Synergies geographic spillovers feature enables systematic analysis of how SDG interactions operate across geographic scales, revealing how policies in one territory influence outcomes in another.**
- **Geographic SDG spillovers reveal where interactions of goals or policy objectives matter most. In Monterrey, Mexico, cross-scale analysis shows that aligning state and metropolitan priorities amplifies synergies and avoids fragmentation in climate policy implementation.**

Introduction

The 2030 Agenda for Sustainable Development, adopted by all United Nations member states in 2015, represents a global effort to achieve the Sustainable Development Goals (SDGs). These are a set of 17 "integrated and indivisible" goals, designed to “leave no one behind”, meaning that all goals and targets must be achieved worldwide (UN, 2015). Since their adoption, SDG researchers have been interested in studying how their integrated nature is brought to practice, accounting for how the goals interact or affect each other. SDG interactions address how progress or obstacles in achieving one SDG can affect progress in another, creating synergies and trade-offs (Bennich et al., 2020; Griggs et al., 2017; Le Blanc, 2015; Nilsson et al., 2018; OECD, 2019; Weitz et al., 2018).

Most SDG interactions studies have been focused on how interlinkages manifest within individual countries, regions or localities. Interactions between countries and geographical scales have been largely overlooked (Bennich et al., 2020), despite the universal scope and integrated nature of the 2030 Agenda. Nonetheless, researchers have proposed that SDG interactions also occur across international borders (Hoff et al., 2019; Sachs et al., 2019; Xiao et al., 2024), between subnational regions and localities (Qin & Zhang, 2022) and geographic scales (Engström et al., 2019, 2021; Hoff, 2018; Liu, 2023; Zhao et al., 2021). For instance, linkages can occur from a city to a country, or vice versa, or between countries. This can be seen in the international trade of a commodity supply chain, for example, suggesting that progress or obstacles in achieving the SDGs in one place can potentially affect SDG implementation in another.

Image: Monterrey, México
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To maximize policy coherence between multiple locations in 2030 Agenda implementation, decision-makers' implementation strategies must consider approaches that account for geographic SDG interactions and the global interconnected nature of the 2030 Agenda. This way, countries can fulfil the pledge to "leave no one behind".

Therefore, researchers at SEI developed a new feature for the SDG Synergies tool, which allows geographic spillover analysis. This responds to research and policy needs to consider how SDG interactions occur across geographic boundaries. In February 2023, the geographic spillover feature of SDG Synergies was tested at a workshop in the city of Monterrey, Nuevo Leon, Mexico. The objective of the workshop was to analyse the policy coherence between the mitigation and adaptation measures of the Nuevo Leon State Climate Change Program (PECC) (Gobierno del Estado de Nuevo León, 2024), which guides the state- and metropolitan-level climate change and environmental objectives in Nuevo Leon and the Monterrey Metropolitan Zone (MMZ), respectively.

This policy brief showcases the new geographic spillovers feature of SDG Synergies – which is expected to be released for public access in 2026 – presenting the results from the Monterrey pilot exercise, and providing some insight and recommendations on how governments can use this tool to conduct SDG geographic spillovers studies.

Methodology: the SDG Synergies geographic spillovers feature

The SDG Synergies tool is a web-based public access platform that allows users to conduct SDG interaction studies using cross-impact analysis and network analysis. SDG Synergies allows for participatory modelling of SDG interactions (Hernández-Orozco et al., 2022; Weitz et al., 2018) and uses a seven-point scale to score interactions between pairs of SDGs. Participants enter their scores into a cross-impact matrix, and the tool then automatically sums and averages the scores to show the synergies (i.e. positive interactions) and trade-offs (i.e. negative interactions) between pairs of SDGs. The tool also displays the aggregate of all interaction scores for each SDG; SDGs with high scores can be prioritized by policymakers to accelerate SDG progress, as they have the potential to positively impact the rest of the 2030 Agenda (Weitz et al., 2018).

The SDG Synergies tool has been used in various interaction studies within single geographic boundaries, such as the national scale (Barquet et al., 2022; Egbende et al., 2023; Hernández-Orozco et al., 2022; Järnberg, 2021) and within national and subnational entities (Carlsen et al., 2022; Hernández-Orozco et al., 2022). Although no explicit applications of the SDG Synergies tool for geographic spillovers were found, cross-impact methodologies have been previously proposed to conduct scenario analysis between multiple scales and territories (Kurniawan, 2020; Kurniawan et al., 2022; Schweizer & Kurniawan, 2016). The geographical spillovers feature of SDG Synergies now enables cross-impact analysis between targets according to their geographical scale. The tool offers subspaces in the matrix (submatrices) corresponding to interactions between pairs of territories.

Following this logic, the geographical spillovers feature of SDG Synergies now allows analyses of SDG interactions between multiple places to be performed directly in the tool, showing how progress or hinderance in the SDGs in one place can affect another (Figure 2). This new feature allows users to include up to three different scales in the analysis, creating submatrices that show the interactions between pairs of countries or scales. The scoring process maintains the seven-point range, disaggregated by submatrices to display the specific interactions and calculations between pairs of scales. The results of this analysis can pinpoint which SDGs can be strategic for international cooperation and policy coherence across scales to advance the 2030 Agenda everywhere, and which SDGs may lead to trade-offs between multiple scales that would need to be avoided or mitigated through negotiation.

Figure 2. Example cross-impact matrix: geographical spillovers between Colombia, Sweden and Stockholm.

Each submatrix represents different interacting places, from top to bottom and left to right: 1) Colombia towards Colombia, 2) Colombia towards Sweden, 3) Colombia towards Stockholm, 4), Sweden towards Colombia, 5) Sweden towards Sweden, 6) Sweden towards Stockholm, 7) Stockholm towards Colombia, 8) Stockholm towards Sweden, and 9) Stockholm towards Stockholm. The number to the right of the rows on each submatrix represents the outdegrees (the degree to which one goal influences all the others, based on the sum of all the goal's outward interactions), while the number on the bottom of the columns shows the indegrees (the degree to which one goal is influenced by all the others, through the sum of all the goal's inward interactions). The coloured dots represent SDG interactions. Deeper colours show higher scores, with blue colours showing synergies and red colours showing trade-offs (see symbology). These results were done for the purpose of demonstrating the tool and do not represent any real exercise or analysis.

Source: Own development using the SDG Synergies tool.

Pilot application on geographical spillovers in the Monterrey Metropolitan Zone and the State of Nuevo Leon

The geographical spillovers feature of SDG Synergies was piloted in a workshop held in the city of Monterrey in February 2023. The objective was to analyse the interactions between the climate change mitigation and adaptation actions of the PECC, whose policies mainly focus on the MMZ, and the state-level policies in Nuevo Leon, as a larger geographical scale. Furthermore, the PECC and state-level policies were mapped to the SDGs to explore the PECC's contribution to the 2030 Agenda. The workshop was attended by 23 participants from government institutions responsible for the implementation of climate policies in the State of Nuevo Leon and the MMZ. The participating environmental institutions in Nuevo Leon were the State Environmental Secretariat (which is the main institution in charge of the design and implementation of the PECC), Civil Defence (which is in charge of disaster reduction and preparedness), and Water and Sewerage Services of Monterrey (a private company that provides drinking water and sanitation services in the state), as well as other government offices involved in the implementation of the PECC.

Table 1 contains the full list of SDG targets considered in the analysis. The workshop participants selected the state-level policy objectives according to the topics their institutions work on and their relevance to climate change and environmental policies in Nuevo Leon. Meanwhile, the State Secretariat for the Environment selected the metropolitan-level actions to study from the PECC. In the SDG Synergies tool, the selected objectives were assigned a prefix: NL for the Nuevo Leon objectives and PC for the PECC actions, as well as consecutive numbers to define the rows and columns of the matrix. At the end of the workshop, SEI researchers mapped these policies to the SDGs in SDG Synergies, assigning an SDG target and a corresponding short title to each of the Nuevo Leon and PECC policies considered in the exercise.

Table 1. State and metropolitan scale SDGs analysed in the pilot study.

State-level climate change policy objectives in Nuevo Leon		
SDG target	**Short title**	**Description**
4.7	Increase environmental education and awareness in Nuevo Leon	Raising environmental awareness by creating an environmental education department, promoting green schools and running educational campaigns in schools.
6.6	Improve water management and efficiency in Nuevo Leon	Improve the state water management plan and increase water efficiency and supply.
7.2	Increase access and production of renewable energy in Nuevo Leon	Carry out efficiency audits, run renewable energy programs for small and medium enterprises, and promote new technologies such as hydrogen fuel.
8.9	Promote sustainable tourism in Nuevo Leon	Promote and increase sustainable tourism, including the promotion of educational programs, while reducing waste from tourism.
10.a	Ensure inclusion and equality in Nuevo Leon	Ensure inclusion and equality by identifying and continuing to support the most vulnerable.
11.2	Improve mobility and transportation in Nuevo Leon	Create cycle routes and encourage sustainable mobility, universal accessibility, and inclusive transport.
11.a	Improve regional planning and development in Nuevo Leon	Improve regional planning and promote the modernization of irrigation systems and the introduction of regenerative grazing systems.
12.4	Improve waste management in Nuevo Leon	Apply the state's Integrated System for the Ecological Management and Processing of Waste.
13.1	Improve disaster risk reduction in Nuevo Leon	Improve the activities of the Civil Protection Institution by developing integrated fire and hazardous materials management plans and programs, executing prevention campaigns, and strengthening rapid response and staff capacity.
13.2	Update the state's Atlas of Natural Hazards	Update the state's natural hazard atlas to reduce vulnerability and support regional planning.

Climate action policies selected from the PECC		
SDG target	**Short title**	**Description**
6.3	Improve and increase treatment of urban wastewater in the MMZ	Actions related to the using wastewater for energy, and improving treatment plants and their reach.
6.6	Ensure preservation of surface water and water ecosystems in the MMZ	Artificial recharge of reservoirs and maintenance of dams and ensuring environmental services for water security.
7.2	Promote clean energy in the MMZ	Promoting clean energy for household water-heating and cooking, reducing fossil fuel use, and encouraging the addition of large-scale wind and solar capacity.
7.3	Promote energy efficiency in the MMZ	Increase the uptake of energy efficiency technologies in homes, industry and infrastructure.
9.4	Increase innovation and sustainable industry in the MMZ	Increase innovation to promote efficiency and productivity of industries and businesses.
11.2	Create and promote low-emissions urban transport in the MMZ	Promote active mobility, public transport and shared vehicles, as well as clean energy for transporting people and goods.
11.6	Improve urban solid waste management in the MMZ	Promote industrial glass recycling and energy production from household waste.
11.7	Increase the number and access to urban green spaces and ecosystems in the MMZ	Increase the number of protected areas and urban green spaces and improve monitoring of these areas.
13.1	Disaster risk reduction and reducing vulnerability in the MMZ	Reduce vulnerability, research the impact of the urban heat island effect, and improve public communication of to weather events.
13.3	Increase climate change education and access to information in the MMZ	Improve early warning systems and access to climate-related information.

Results

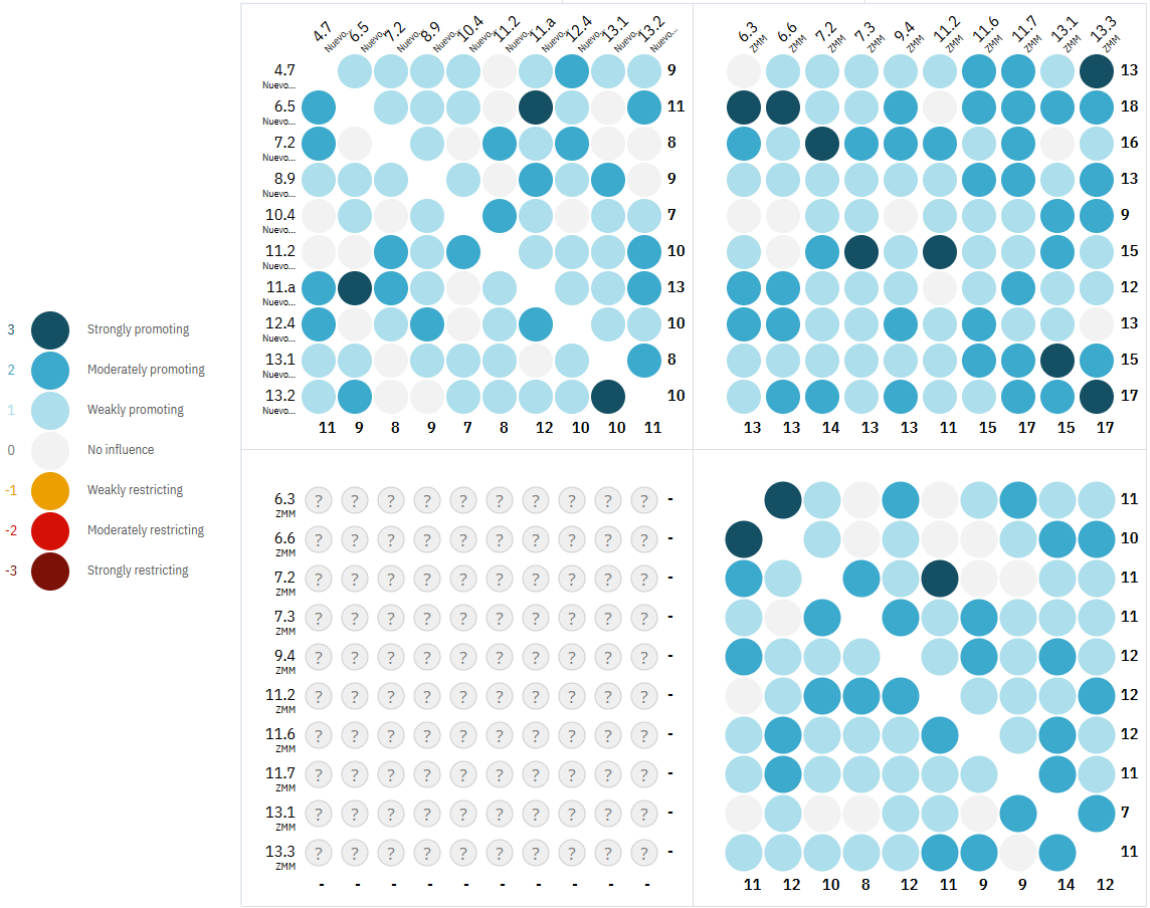
To showcase the geographical spillovers feature, the outdegree scores – the degree to which one goal influences all the others, based on the sum of all the goals' outward interactions – of each of the sub-matrices from the pilot exercise are presented in Figure 3. The participants did not score how metropolitan-level actions affect state-level interactions because the exercise prioritized the analysis of how state-level policies influence metropolitan-level policies, and policy interactions within their own scale (see Figure 3). In presenting these results, when we refer to the MMZ, the PECC and Monterrey, we are referring to SDGs at the metropolitan level, while Nuevo Leon refers to the state level.

Regarding the submatrices that show interactions within their own geographical scales, in the submatrix corresponding to the Nuevo Leon scale (top-left submatrix in Figure 3), the two most impactful SDG targets are 11.a (Improve regional planning and development in Nuevo Leon) and 6.5 (Improve water management and efficiency in Nuevo Leon), with outdegrees of 13 and 11, respectively. In the MMZ submatrix (bottom-right submatrix in Figure 3), there is a triple tie for the most impactful target with SDGs 9.4 (Increase innovation and sustainable industry in Monterrey), 11.2 (Create and promote low-emissions urban transport in Monterrey), and 11.6 (Improve the management of urban solid waste in Monterrey) with outdegrees of 12. These measures will have the greatest synergistic effect for implementing the PECC, as they are the most influential actions.

On the other hand, the submatrix showing the cross-scale interactions from the Nuevo Leon scale to the MMZ scale (top-right submatrix in Figure 3) reveals that the most impactful SDG targets are 6.5 (Improve water management and efficiency in Nuevo Leon, scored 18), 13.2 (Update the state's Atlas of Natural Hazards, scored 17),

and 7.2 (Increase access and production of renewable energy in Nuevo Leon, scored 16). Furthermore, Nuevo Leon's SDG target 6.5 (Improve water management and efficiency in Nuevo Leon) has strong synergy scores of +3 with MMZ SDG targets 6.3 (Improve and increase treatment of urban wastewater in Monterrey) and 6.6 (Ensure preservation of surface water and water ecosystems in Monterrey). The Nuevo Leon State SDG target 13.2 (Update the state's Atlas of Natural Hazards) has synergy scores of +3 with MMZ SDG target 13.3 (Increase climate change education and access to information in Monterrey). Finally, Nuevo Leon SDG target 7.2 (Increase access and production of renewable energy in Nuevo Leon) presents a synergy score of +3 with MMZ SDG target 7.2 (Promote clean energy in Monterrey). These results suggest that there are objectives at the state level, mainly related to water management, disaster risk reduction and renewable energy access, that can directly improve the implementation and execution of the PECC. In this sense, it is critical that the state institutions in charge of these issues work closely with the agencies carrying out the actions of the PECC.

Figure 3. SDG geographical spillovers between Nuevo Leon and the MMZ in the implementation of the PECC.



Each submatrix represents different interacting places. From top to bottom and left to right, the scored geographical interactions are: 1) how Nuevo Leon policies affect each other within Nuevo Leon, 2) how Nuevo Leon policies affect MMZ policies, and on the bottom right 3) how MMZ policies affect each other within the MMZ. The bottom left submatrix was not scored (interactions from the MMZ to Nuevo Leon). The coloured dots represent SDG interactions as described in the scoring scale (from 3 to -3). See more information on the scoring process, including outdegree and indegree scores, in Figure 2.
(ZMM stands for MMZ in Spanish.)

Source: Own development using the SDG Synergies tool.

Furthermore, the results show a matrix with no trade-offs and strong synergies between state-scale objectives and the PECC, which suggests that there is a strong coherence between the climate objectives in Nuevo Leon and those of the MMZ. This indicates that state-level policy objectives do not conflict with MMZ objectives and can promote climate action in the MMZ. However, while these synergies may occur due to shared views and common goals on climate change and environmental policy between institutions in the region, it is important to develop policy coordination mechanisms to avoid conflicts between institutions (Peters, 2018; van Leeuwen et al., 2014; Voyer et al., 2020) and reduce inefficiencies in policy design and implementation (Adam et al., 2019). In this way, ensuring policy coordination may help maximize the synergies that arise from shared goals (Voyer et al., 2020).

Therefore, to continue this work, government practitioners should delve deeper into the region's existing coordination mechanisms and how they are operationalized in the PECC to realize the policies' synergy potential. In case the coordination mechanisms are lacking or inadequate, decision-makers should propose approaches to improve them or implement new ones. Following this line of reasoning, assessing coordination mechanisms between scales can be a second step after identifying SDG cross-scale interactions. Moreover, although the pilot exercise did not generate trade-offs, policy coordination can be a valuable approach in reducing conflict and therefore eliminating or mitigating trade-offs.

In summary, the geographical spillovers feature of SDG Synergies allowed us to analyse how SDG targets can have different impacts depending on the scale at which these interactions occur, and whether the interactions occur across scales. Furthermore, the cross-scale analysis can show how policies at a larger scale can support the implementation of policies at a smaller scale, and which SDGs can be more impactful, as shown by the SDG interactions from Nuevo Leon to the MMZ. In this way, the tool can make promote vertical policy coherence and accelerate the achievement of the SDGs.

Recommendations for considering geographical spillovers in SDG interaction studies

The geographic spillovers feature of SDG Synergies will be made publicly available in 2026, allowing decision-makers and researchers to conduct international spillover and cross-scale analyses in the implementation of the 2030 Agenda. Based on this pilot study, we make the following recommendations:

- **We recommend conducting SDG geographic interactions studies in the implementation of the 2030 Agenda to enhance policy coherence across countries and scales.** In this regard, the new geographical spillovers feature of SDG Synergies is a practical approach that allows the analysis of interactions between places and scales. It generates disaggregated calculations to show how the SDGs can have different impacts when the interactions occur across scales. This can make a valuable contribution in the study of geographical SDG interactions.

- **The research community must work with policymakers to further develop and apply methodologies that allow conducting SDG geographical spillovers analyses.** The application of such methodologies can be used for the development of policies or in preparation of SDG progress reports, such as Voluntary Local Reviews and Voluntary National Reviews.

- The use of the geographical spillovers feature in Nuevo Leon and the MMZ revealed strong synergies between state and metropolitan level SDGs. While this may indicate the existence of policy coherence, **we recommend delving deeper into the coordination mechanisms behind these synergies to assess whether they being realised.** The analysis of coordination mechanisms could be a second step in the pursue of maximising synergies across scales.

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